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RUBBER RESEARCH INSTITUTE

OF

MALAYA.

IMPERIAL COLLEGE
11 JULY 1932
INSTITUTE

ANNUAL REPORT 1931.

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The constitution of this Committee is as follows:—

One member nominated by the Colonial Advisory Council of Agriculture and Animal Health.
One member nominated by the Malayan Governments.
One member nominated by the Ceylon Government.
Three members representing Malayan Planting interests.
Three members representing Ceylon Planting interests.
Two members representing Manufacturing interests.

Ex-Officio
The Director of the Imperial Institute.
The Director of the Botanical Laboratories, Imperial College of Science and Technology.
The Director of the Imperial Bureau of Mycology, Kew.
The Director of Rothamstead Experimental Station.

ANNUAL REPORT OF THE BOARD

—— FOR ——

THE YEAR ENDED 31ST DECEMBER, 1931.

The year 1931 may be said to be the fifth completed year of active operation of the Institute, taking the active operations of the Institute to have commenced from the appointment of a Director in September 1926.

BOARD MEMBERSHIP.

The following changes in the personnel of the Board took place during the year :—

(a) The Director of Agriculture S.S. and F.M.S. (Dr. H. A. Tempany) went on long leave on the 12th June 1931. Mr. F. W. South, who became Acting Director of Agriculture, succeeded him and continued in office till the close of the year.

(b) Che' Hamzah bin Abdullah was re-appointed by H.E. the High Commissioner F.M.S. to represent the interests of Small-holders for a further term of three years with effect from 8th August 1931.

(c) The Secretary to the High Commissioner, nominated by the High Commissioner to represent the States of Johore, Kedah, Perlis, Kelantan and Trengganu was re-appointed for a further term of three years with effect from 10th December 1931.
Mr. J. D. Hall, as Acting Secretary to the High Commissioner, held office until the 24th July from which date Mr. E. E. F. Pretty became Acting Secretary.

(d) Mr. C. B. Graburn, one of the two representatives of the Rubber Growers' Association was absent on long leave from the 1st April to the 31st October. During his absence Mr. G. Eric Teale was appointed to act in his stead.

(e) Mr. E. N. T. Cummins, one of the two representatives of the Planters' Association of Malaya proceeded on long leave on the 6th May. Mr. R. S. Chantler is acting as his substitute.

(f) The term of office of the Treasurer F.M.S., the Financial Officer nominated by the High Commissioner, expired on the 9th December and was extended for a further term of three years from that date.

The Hon. Mr. G. P. Bradney who has held this appointment during the year relinquishes the office on the 31st December when the Hon. Mr. Marcus Rex assumes duty.

The final composition of the Board at the end of the year was as follows :—

(a) President and Chairman—F. W. South Esq., Acting Director of Agriculture, S.S. and F.M.S.

(b) Member nominated by the High Commissioner to represent the interests of Small-holders—Che' Hamzah bin Abdullah.

(c) Member nominated by the High Commissioner to represent the States of Johore, Kedah, Perlis, Kelantan and Trengganu—The Secretary to the High Commissioner (E. E. F. Pretty Esq.)

(d) Members appointed by the Rubber Growers' Association —The Hon. Mr. J. S. Arter and C. B. Graburn Esq.

(e) Members appointed by the Planters' Association of Malaya—The Hon. Mr. H. B. Egmont Hake and R. S. Chantler Esq.

(f) Member appointed by the Asiatic Planters' Association of Malaya—K. Arumugam Esq.

(g) Financial Officer nominated by the High Commissioner— The Treasurer F.M.S. (The Hon. Mr. G. P. Bradney).

BOARD AND COMMITTEE MEETINGS.

During the year 40 Meetings of the Board and of its Committees were held as follows :—

Ordinary Meetings of the Board	...	5
Executive Committee	...	14
Finance Committee	...	12
Experiment Station Committee	...	6
Rubber Roadways Research Committee	...	3
		40

ACCOUNTS.

The accounts for the year ended 31st December 1931 as passed by the Auditors of the Institute are printed as an Appendix to this Report. The accounts will be published in the F.M.S. Government Gazette in due course.

INCOME.

The following statement shows the collections made by and the contributions received from the various Administrations during each year of the Institute's existence up to the 31st December 1931 :—

———	F.M.S.	S.S.	Johore	Kedah	Kelantan	Trengganu	Total for year
Income prior to incorporation i.e to 1st Sept. 1925 ...	$ 130,664	32,805	37,500	15,750	..	1,648	218,367
1925 (1st Sept. to 31st Dec.) ...	81,020	14,580	16,668	7,000	...	608	119,876
1926	269,145	60,705	50,000	21,000	7,837	2,881	411,568
1927 ...	214,371	48,540	50,000	21,000	9,837	3,002	346,750
1928 ...	293,079	65,942	50,000	21,000	9,603	2,820	442,444
1929 ..	437,495	95,000	50,000	21,000	13,733	3,714	620,942
1930 ...	419,420	76,591	50,000	46,386	11,972	3,355	607,724
1931 ...	405,158	76,591	50,000	67,160	, 85	*2,320	609,086
Total Income to 31st Dec. 1931 ...	$2,250,352	470,754	354,168	220,296	60,839	20,348	3,376,757
Percentages ...	66.64	13.94	10.49	6.53	1.80	0.60	100

* Contribution for 4th quarter not included.

CAPITAL AND RECURRENT EXPENDITURE.

The following table shows the Special (or Capital) and Recurrent Expenditure in each year up to the end of 1931 :—

			Capital Expenditure.	Recurrent Expenditure.
1925,	... ...		$ 28,565	$ 3,431
1926,	... ...		172,673	54,934
1927,	... ...		381,330	276,712
1928.	Institute, ...	$159,820		
	Experiment Station ...	47,752	207,572	396,341
1929,	Institute ...	23,734		
	Experiment Station ...	293,968	317,702	461,622
1930,	Institute ...	45,085		
	Experiment Station ...	105,437	150,522	512,828
1931,	Institute ...	2,450		
	Experiment Station ...	17,143	19,593	563,134

PROVIDENT FUND.

The Statement of Accounts and the Report for the year 1931 disclose that the sound position of the fund has been maintained. The distribution of income for the first half-year was 2.77% and for the second half-year 2% making a total distribution of 4.77% which may be regarded as quite satisfactory.

CONSTITUTION.

During the year a new Association named the Malayan Estate Owners' Association came into existence absorbing the Asiatic Planters' Association of Malaya. The Board thereupon took steps to amend its constitution and an Amending Enactment passed the Federal Council towards the end of the year giving power to the Malayan Estate Owners' Association to nominate two members to the Board. As the Amending Enactment had not come into effect by the close of the year by publication in the F.M.S. Government Gazette, the members representing the new Association had not at that time taken their seats.

RUBBER ROADWAYS COMMITTEE.

The Rubber Roadways Committee has held three meetings during the year. Much preliminary ground has been covered and some progress has been made but matters have not yet advanced sufficiently far for any test sections of road to be laid down.

COLLECTIONS AND CONTRIBUTIONS FROM ADMINISTRATIONS.

During the year the collection of the cess has been placed on a legal footing in the State of Kelantan.

In Trengganu similar action is being taken and it is anticipated that in this State also the collection of the cess will shortly be placed on the same footing.

Negotiations have continued in regard to the payment of the cess in one of the other States but no definite conclusion had been arrived at by the end of December.

ECONOMIES COMMITTEE.

An Economies Committee was appointed in August and as a result of its recommendations certain reductions were made under several heads of expenditure. The main line of economy was that made in the salaries of the staff and a reduction affecting the whole staff comes into effect as from the 1st January 1932.

HEADS OF DIVISIONS.

During the year a decision was reached in regard to the Headship of the Botanical Division, Mr. C. E. T. Mann, Plant Physiologist, being selected for promotion to the appointment on his return from leave. Mr. Mann is due to return in the early part of February 1932.

As reported in the last annual report, Mr. A. Sharples, Department of Agriculture, assumed appointment as Head of the Pathological Division on his return from leave in February 1931.

(Sgd.) H. A. TEMPANY,
President and Chairman, 1931.

ANNUAL REPORT

BY

THE DIRECTOR.

Introduction.

The year 1931 constitutes the fifth complete year of the Institute's existence, although the greater portion of the staff was not recruited until the middle and end of 1927.

The advisory work of several Divisions has again increased. This is indicated not only by the correspondence but also by the large number of planters who visit the Institute and the Experiment Station for advice.

The chief feature of such advisory work has been in relation to improvement in estate factory practice, in order to reduce cost of production. Considerable interest has also been taken in the so-called forestry methods of cultivation while interest in budding programmes and in relation to disease problems and replanting schemes on old rubber areas on which declining yields due to root diseases are indicated has been maintained.

For the first time in the history of the plantation rubber industry in Malaya, apart from attacks of white ants, an insect pest in the form of the grub or caterpillar of a cockchafer has caused damage to the roots of rubber trees over a considerable area on one estate. This has necessitated the loan of the part time services of the Government Entomologist of the Department of Agriculture, to collaborate with the Pathological Division of the Institute in control measures.

Staff.

BOTANICAL DIVISION.

Mr. C. E. T. Mann was appointed Head of the Division with effect from his return from service leave. He was on leave from 17th June until the end of the year.

Messrs. C. E. T. Mann and L. E. Morris continued to share the work of the Division until Mr. Mann proceeded on leave, when Mr. Morris acted as Head of the Division.

Mr. C. C. T. Sharp assumed duties on the 25th February.

Mr. H. Gunnery, Technician, was transferred to the Pathological Division, although he still undertakes any work required for other Divisions.

PATHOLOGICAL DIVISION.

Mr. A. R. Sanderson, Acting Head of the Division retired on age limit on the 4th April.

Mr. A. Sharples, Government Mycologist, Department of Agriculture, S.S. & F.M.S. was seconded for service with the Institute and assumed duties as Head of the Division on his return from leave on the 15th February.

Mr. F. Beeley was transferred from the Field Division to the Pathological Division, but owing to illness was compelled to proceed on leave on the 14th August.

Dr. A. S. Corbet, who will be attached to the Pathological Division, was also on leave with effect from 3rd May for the remainder of the year.

SOILS DIVISION.

Dr. W. B. Haines returned from leave and resumed duties on the 28th February, 1931.

CHEMICAL DIVISION.

Dr. E. Rhodes proceeded on leave on the 11th June and was absent for the rest of the year.

Mr. R. G. Fullerton who was granted leave in November 1930 returned and assumed duties on the 18th October.

Mr. J. D. Hastings was appointed Temporary Chemist for investigations in relation to rubber roadways and assumed duties on the 8th May.

FIELD DIVISION.

The appointment of Chief Field Officer was abolished.

Mr. G. Davidson was allocated as Field Officer, Kedah, Province Wellesley and Kelantan, but did not take up these duties until early in 1932.

Mr. F. Billington proceeded on leave on the 20th February and resumed duties on the 15th October.

Mr. N. C. Jenkins, Field Officer, Johore proceeded on leave on the 18th September.

Mr. A. Moore assumed duties as Field Officer on the 7th August 1931 and was allocated to Johore with effect from the 23rd September.

EXPERIMENT STATION.

Mr. D. S. Gardner, Visiting Agent, proceeded on leave on the 10th July and Mr. A. Douglas was appointed to act until Mr. Gardner's return in 1932.

Mr. A. E. Ford continued to act temporarily as Assistant Manager till 31st January.

Mr. H. G. W. Mathews assumed duties as Assistant Manager on the 1st February.

GENERAL.

Apart from the above changes, the remainder of the staff was on duty throughout the year.

Advisory Work.

The advisory work of the Institute continues to increase in several directions, although there has been a decrease in relation to soil and manuring problems, chiefly on account of the fact that most estates have been unable to commence or continue the use of fertilizers owing to the low price of rubber throughout the year.

The principal increase in such advisory work has been in the Chemical Division, due to the great interest which is being taken in the reduction of estate factory costs.

It may also be stated and emphasised here that the results of investigations carried out and published by the Institute also tends to increase such advisory work, since in many instances, each estate has its own peculiar conditions, involving modifications in practice, which require further investigation, advice and frequently personal visits to the estate.

The considerable increase in work of this nature indicates a healthy interest in the work of the Institute and the correspondence received from many managers show that the advice is of value and is appreciated.

Although this work interferes with and slows up the progress of research on various fundamental problems, it may be desirable to state here that we have not lost sight of the greater importance to the industry generally of continuing investigations on the larger and more fundamental problems. This is essential if we are to maintain our progress vis a vis our competitors in other countries.

The views of a writer in one of the technical rubber journals are of interest in this connection. He writes " In times of economy " any work which shows no signs of results which can be turned " into money in a short time is apt to be frowned upon and ordered " to the shelf to give place to ideas which can be more quickly " developed. One must sympathise with this attitude even though " it must be fought, since the patience which has gone to make pos- " sible the epoch-making developments of the centuries is generally " quite inconceivable to business men. Turning research into a money " making machine by design is not likely to be a success, for nothing

"is more impatient of interruption and there is another danger that "in insisting on work showing immediate returns only the shallow "and relatively unimportant problems will be tackled.

"A certain return will be made it is true: but outlook and in- "itiative for the really worth while problems, which bring com- "mercial superiority to those who solve them, will gradually be "stifled, leaving in the end men who are too narrow in outlook to "work fundamentally, and who cannot bring to a firm those suc- "cesses which should be enjoyed when adequately planned research "is carried on to fruition."

In relation to advisory work on budding it is of interest to note that the latest figures show an area of approximately 136,000 acres of budded rubber in Malaya.

Problems in relation to technique, especially in the treatment of buddings of large stock require investigation and observation and the growth records of various clones on different soil types have to be studied.

During the year 6130 letters have been received which include 3777 dealing with planting problems.

In addition, numerous planters have visited both the Institute and the Experiment Station in order to discuss special problems relating to their estates.

The principal enquiries are indicated in the following summary:—

Budding	567
Manuring, Soil Conservation and Drainage ...	165
Soil Examinations	56
Rubber Diseases	514
Estate Factory Practice (Preparation of and Defects in Raw Rubber)	1174

A detailed summary is given in the appendix to the report of each Division.

The allocation of Field Officers to Johore and to Province Wellesley and Kedah is proving of considerable value in relieving officers at Headquarters from excessive travelling and thus saving time and money. Preliminary observations and investigations by these officers are also of considerable value in enabling the Research Officers to advise on a specific problem, when the Field Officer may not be able to provide the advice direct.

As during the previous year, cordial and valuable co-operation has continued to exist with the Department of Agriculture, S.S. and F.M.S. and the Co-operative Societies Department, S.S. & F.M.S. in relation to work on small holdings and in other directions. Owing to the slump in market prices of raw rubber, however, little progress has been made in the formation of co-operative factories or

smoke-houses for the preparation of good grades of rubber on small holdings.

Some progress has been made on a small scale in one centre, by the erection of a co-operative smoke-house and the grading of the smoked sheet for the market.

The Director of the Institute has continued to be a member of the Advisory Committee, the Publicity Committee and Agricultural Pests Advisory Committee of the Department of Agriculture, and of the Advisory Board and Film Propaganda Committee of the Co-operative Societies Department.

Membership of the Advisory Board and Publicity Committee of the Department of Agriculture enables the Director to maintain close touch with agricultural problems in Malaya other than rubber and with the work of the Agricultural Field Officers of the Department of Agriculture in relation especially to rubber disease control on small holdings.

Close contact has been maintained by frequent correspondence between the Rubber Research Scheme, Ceylon, the AVROS Proefstation in Sumatra and the Rubber Proefstation in Java. Dr. Riebl, Chemist of the last named Proefstation visited the Institute and a number of estates and re-milling factories in Malaya.

Valuable interchange of correspondence has also taken place with the Superintendent of Laboratories (Mr. G. Martin) of the Rubber Research Scheme, Ceylon at the Imperial Institute.

I wish particularly however to refer to the considerable help and advice of the Director of the Research Association of British Rubber Manufacturers (Mr. B. D. Porritt). Almost weekly correspondence on various problems has been exchanged between the Institute and this Association.

This co-operation has been of considerable value and will be continued, since we realise that it is essential to maintain the closest liaison with rubber manufacturers in order to ascertain the requirements of the manufacturing industry. Such liaison and co-operation can be best maintained between the research organisations representing the producing and manufacturing sides of the rubber industry and can be most effective if carried out in this manner.

Co-operation with the Rubber Growers' Association on various matters of technical interest has also been maintained and the advice of this Association obtained on a number of problems, especially in relation to new uses for rubber.

In view of the research programme in relation to new uses of rubber which has been commenced under the auspices of the Rubber Growers' Association, it will be necessary to maintain still closer liaison. The assistance of the Institute has already been invoked by the Association in connection with further researches on

the preservation and concentration of latex, while problems in relation to the application of rubber or latex to roadways are receiving the attention of both organisations and correspondence on the progress of such investigations is exchanged.

London Advisory Committee.

Although information was not received until early in 1932, it is of interest to note that the efforts to effect a combination of the London Advisory Committees of this Institute and the Rubber Research Scheme, Ceylon have been successful and a Joint Committee is now functioning.

Film Propaganda—Rural Lecture Caravan.

The Rural Lecture Caravan, which is operated jointly by the Department of Agriculture, S.S. & F.M.S., the Co-operative Societies Department, F.M.S. & S.S. and this Institute, primarily for propaganda work among small holders in relation to rubber, other agricultural products and co-operative methods of preparation and marketing of agricultural produce completed its first annual tour.

Twelve tours were undertaken which included six in Selangor, three in Perak, two in Negri Sembilan, one in Penang and Province Wellesley (which also included one of the tours in Perak) and one in Malacca.

In relation to propaganda work on behalf of the Institute, this consisted chiefly of lectures on Mouldy Rot illustrated by means of lantern slides, which were considered more effective for the purpose than a film. Towards the end of the year, a film dealing with co-operative methods of preparing and marketing rubber, emphasizing particularly the importance of cleanliness and grading of sheet rubber was prepared by the Co-operative Societies Department and shown in various districts.

Films have been prepared and are used for other propaganda work carried out by the Department of Agriculture and the Co-operative Societies Department during the tours.

Judging from the reports received from the Agricultural Field Officers of the Department of Agriculture in the Districts visited useful results were obtained and valuable criticisms were received for future improvements in the methods of propaganda.

A trailer has now been completed which will be attached to the van for tours during 1932.

This trailer is fitted for the transport of specimens of rubber, rubber tree diseases and other exhibits which may be found to be of use for demonstration purposes.

The original method of operating the film projector dynamo from the back wheel of the van has been found to be unsatisfactory and a small portable 1½ H.P. engine coupled direct to the dynamo has now been purchased.

Excellent audiences were present at most of the centres visited and this method of dissemination of information on agricultural and co-operative problems is undoubtedly proving of considerable value.

A detailed report on the work of the van during 1931 is being prepared for publication in the Malayan Agricultural Journal to which those who are interested are referred for further information.

Soil Investigations and Manuring.

Owing to the financial conditions of the industry less attention has been paid to the application of fertilizers for the improvement of yield on poor areas, especially since it has been demonstrated that comparatively large increases of crop must be obtained in order to compensate for the cost of fertilizers and their application. Some estates have not been able to continue experimental work already in progress.

Owing to the assistance rendered and grants of fertilizers by the two principal fertilizer firms—Imperial Chemical Industries and Malayan Fertilizers Ltd.—experimental work is still in progress on a number of estates and the Soils Division of the Institute is keeping in touch with these experiments.

A comprehensive article, published by the Soils Division in the Institute Journal (Vol. 3. No. 2) shows that, generally, the manuring of well grown, vigorous and healthy rubber trees giving a yield of above 400 lbs. of dry rubber per acre usually gives no notable increase of crop, while useful increases are obtained on areas yielding between 200 and 300 lbs. of dry rubber per acre.

This result is doubtless due to the fact that each individual tree has an optimum yield which is not materially increased by the application of fertilizers.

In the case of poor trees with scant foliage and inferior bark, considerable improvement of both foliage and bark has been observed in practically all cases by the application of fertilizers, especially nitrogen, although the application of potash has also been essential on some poor sandy areas. Increased yield of crop is however frequently delayed until improvement in the vegetative character of the tree has been attained.

The problem of the maintenance of yield and the health and vigour of the tree by the application of fertilizers is however a separate problem and may prove to be of more economic significance in the case of high yielding material in the form of budded plants or high yielding seedling material.

The low price of rubber, combined with the mixed population of our present estates, in relation to individual tree yields, preclude the continuance of manuring programmes at the present time, since large increases of yield are essential to compensate for the cost of fertilizers.

These results confirm observations and results published in the Netherlands East Indies.

Cover Plants and Forestry Methods of Cultivation.

Considerable attention however is being devoted to other methods of maintaining and improving soil fertility.

In this respect the situation in relation to soil erosion and maintenance of humus in the surface soil may be regarded as satisfactory on most estates. Much interest has been aroused in the so-called forestry method of cultivation of the rubber tree which has been adopted with considerable success by Mr. E. Birkemose on an estate in Pahang.

The advocacy of such methods by Dr. Whitford, the representative of the Rubber Manufacturers' Association of New York, who is investigating the rubber situation in the plantation rubber producing countries of the Eastern tropics, in several public lectures in Malaya has focussed the attention of the planting community on such methods, and this has been increased by the probability of a number of estates having to be placed on a "care and maintenance" basis. Much correspondence has appeared in the local press and numerous enquiries have been addressed to the Institute on this problem.

In this connection it is apropos to quote a statement by the Head of the Soils Division in the article on Manuring referred to above. "There is every indication that the planting practice of the future will be along forestry lines in which the nitrogen supply of the soil is nicely regulated through the effect of the selective growth of natural covers on the volume and nature of vegetable debris reaching the soil, and the light, heat and moisture conditions under which it decays. The pioneer work already done in this direction has been so successful that, however long the establishment may take, we may regard ourselves as at the point of a new departure. Such methods require skilled direction but the minimum amount of labour and expenditure in execution."

A special bulletin (No. 4) entitled "Summary of Meteorological Records, Soils Division" published by the Institute during the year also indicates the value and significance of such methods in relation to the maintenance of humus in the surface soil, prevention of erosion and maintenance of suitable soil temperatures to prevent rapid deterioration of soils by the oxidation or "burning out" of the organic matter in the soil accumulated under forest conditions.

The basic principles of the method consist in permitting the growth and development of certain secondary jungle growth (belukar) which, while doing no harm to the main crop, conserves the valuable surface soil by preventing erosion and maintaining the soil temperature at a point which is near that under forest conditions.

This is of particular importance during the first four to five years of the life of a rubber estate, before shading produced by the rubber tree is effective.

Little or nothing is however known at present in relation to the incidence of root diseases of the rubber tree under these conditions and such information will only be available after several years of observation and experiment.

A memorandum, embodying the views of the Institute on this problem in relation to fertility and root diseases and its application to modern planting practice, especially in regard to the planting of budded material, will be issued shortly.

It may be desirable, however, to emphasize at this juncture the fact that, on a number of eroded and badly leached soils on estates in certain parts of this country, which have been cultivated with other crops for 50 or more years, before rubber trees were planted on these areas, such methods cannot give any results of value for many years.

There can be little or no hope of the economic improvement of such areas, with the probable future market prices of raw rubber. These estates have only existed as an agricultural industry owing to the phenomenally high prices of raw rubber caused by the rapid development of the rubber manufacturing industry during the short period of about two decades.

In general, in relation to rubber estate soils, it may be stated that the soil profile is an excellent indication of the suitability of the land for the cultivation of the rubber tree.

A shallow soil is not likely to be benefitted or ameliorated to a sufficient extent to be an economic agricultural proposition for rubber cultivation..

Laboratory Investigations.

Laboratory investigations combined with field observations have been continued in various directions with the object of correlating laboratory results with estate practice. Much attention has been devoted to new methods of improved technique.

Experiment Station.

Records have been continued on plots under the control of the Division, in relation to the manurial block (No. 6), cover crops versus clean weeding and the blocks under "forestry methods of cultivation." Further results when ready will be published in the Journal.

A soils map with notes on the main types of soil on the area already opened and planted at the Experiment Station has been prepared by the Soils Division and is published on page 33 and in the Journal (Vol 3. No. 3).

Botanical Investigations.

Budding Operations.

Although, owing to financial circumstances, budding programmes have been postponed or delayed on a number of estates, satisfactory progress has still been maintained. Statistics published by the Registrar-General of Statistics indicate that a total area of over 134,000 acres had been budded in Malaya at the end of 1931. These figures do not include an area of at least 2,000 acres in Kelantan, and agree closely with the area estimated by us.

The importation of budwood from outside Malaya, chiefly from the Netherlands East Indies, again shows a large decrease, which is due to the establishment of multiplication nurseries on estates in Malaya and to the planting of the more promising Malayan clones now available.

The total importation of budwood during the year amounted to 6,039 metres.

The principal clones represented were :—

Clone	Tjr. 1	2,742 metres.
,,	B.D. 5	978 ,,
,,	B.D. 10	750 ,,
,,	AVROS. 256	281 ,,
,,	Tjr. 16	265 ,,
,,	Tjr. 3	200 ,,
,,	Tjr. 8	200 ,,
,,	AVROS. 50	180 ,,

Almost the whole of the budwood of Clone Tjr. 1 was imported by one estate and of Clone B.D. 10 by another estate.

In addition 5,000 Wangoenredja Estate (Java) seeds were imported.

Records of Malayan Clones.

Records have been received periodically by the Institute of the yields of the most promising Malayan clones, while tapping of the Pilmoor Estate clones has been continued by the Institute. The results are summarised in the Report of the Botanical Division.

Through the courtesy of the Manager of Glenshiel Estate, several tapping systems have been applied on groups of trees of the promising Glenshiel Clone No. 1.

Tapping records of the principal Prang Besar Estate clones have been received from the Manager of the estate, through the courtesy of the Agents (Harrisons, Barker & Co., Ltd.).

New Malayan Clones.

The records of yields of high yielding trees from a number of Malayan estates have been continued and budwood has now been obtained and seedlings have been budded at the Institute Experiment Station with the object of developing new Malayan clones. Buddings from 149 mother trees have already been made during the last season. In each case groups of 20 trees have been budded using Clone AVROS No. 50 as a standard.

Additional clones have also been added to the collection at the Experiment Station.

New clones have also been established from the seedlings raised by artificial cross pollination of certain clones.

Growth records of the principal clones are being recorded at the Experiment Station and on various estates throughout the country in order to study the variations in the development of clones under different environmental conditions.

The study of the distinctive vegetative characters of clones has been continued for the purpose of identification. Preliminary trials of Bobilioff's colour test on the latex from young plants, which is based on the presence of oxidases and substances in the latex which are coloured by such oxidases, have also been made.

Observations and records are being continued on a number of areas of old rubber which have been replanted with high yielding material.

Laboratory investigations on the latex vessel systems of the Pilmoore clones has been continued, but the results are not yet ready for discussion and publication.

Two 5 acre isolated blocks have been obtained in the Forest Reserve near the Experiment Station and planted with stumps for budding with *Hevea Spruceana* in one area and mixing with clones of *H. Brasiliensis in the other.*

Buddings on stocks at different heights have also been made at the Experiment Station to study the yield of both scion and stock.

Mono-clone planting i.e., the planting of single clones in a block is now generally favoured and adopted.

Budding Technique.

The advice of the Institute has been sought in relation to the budding of large stocks of 3 years of age or more. No previous experience was available and no stocks of suitable size at the Experiment Station for carrying out experiments until recently.

Experiments with budwood of different maturity and the opening of the bandages at different intervals have now been undertaken.

It has been shown that brown budwood is preferable to green budwood although, where the supply of budwood is limited, the latter can be used.

Treatment of Budded Stock.

The most important feature, however, is the treatment of the snag of large stocks, both in relation to the pruning of the stock and the application of wound dressings to the pruned surface.

Although the asphalt-kerosene mixture recommended as a wound dressing for the pruned surface of the stock has proved satisfactory on a number of estates, on others, Die-back and Ustulina Fungi have attacked the pruned surface of the stock and the union. This may be due to lack of supervision in preparation of the mixture and its application.

However, investigations of other wound dressings are being made, and it appears that a suitable wax containing sulphur may be preferable, provided shading of the pruned surface is adopted.

Test Tapping.

Test-tapping of young trees at the Experiment Station and on several estates has been carried out with the object of correlating the yields obtained at different ages with the subsequent commercial yields of the "mature" trees when they reach a tappable age, in order to ascertain whether the test tapping records can be used as a basis for thinning out of poor yielders.

At present no method of determining whether a young budding or seedling will become a high yielder is available and the results already obtained do not show a close correlation between yield and vegetative characters such as girth, number of latex vessels or bark thickness.

Seed Selection and Pollination.

Owing to the poor seeding season and poor germination, it was possible to obtain seed from the high yielding mother trees selected for budwood from only 19 trees on eight estates. The seedlings raised from these seeds have been planted in Block 25 at the Experiment Station for comparison with the clones derived from these trees. At present 34 tree families of such seedlings from 15 estates have been planted.

Seeds from several well known Malayan clones have also been planted at the Experiment Station. Combinations of all the six

highest yielding Pilmoor clones have now been effected by hand pollination and crosses of the Pilmoor clones with Glenshiel clone No. 1.

The percentage of successes by hand pollination still remains low.

Records of growth of "pedigree" seedlings have been continued at the Experiment Station.

Certain families are outstanding in respect of prolific branching and girth which suggests that vigour of growth is determined by hereditary as well as environmental factors. Striking similarity of branch form is also noted between seedlings from similar "pedigree" seed.

Cover Plants.

In view of the interest which is being taken in forestry methods of cultivation, a large number of weeds and secondary jungle plants have been received for identification and opinions as to their harmful or valuable effects as covers for the maintenance of soil fertility.

The special cover crop demonstration plots at the Experiment Station have been re-arranged, since a number of the plants were found to be unsuitable and these have been retained only on smaller plots.

Experiment Station.

Sufficient areas were available on the land at present opened for planting for the programme drawn up by the Botanical Division. A re-organisation and reduction in size of some of the blocks reserved for the Pathological Division has also enabled areas to be handed over to the Botanical Division for experimental purposes.

Diseases and Pests.

There have been no special outbreaks of disease during the year. Mouldy Rot (*Sphaeronema fimbriatum*) of the tapping panel has however been very virulent during the wet season on small holdings and Pink Disease (*Corticium Salmonicolor*) has caused trouble in some parts of Northern Perak and in Kedah.

Root Diseases.

Considerable progress has been made in the study of root diseases of the rubber tree and new knowledge obtained. The publication of Bulletin No. 3 on "The Root Disease Problem in Old Rubber Areas in Malaya" by the Pathological Division has added useful knowledge to the problem of the principal root diseases of the rubber tree in Malaya—*Fomes lignosus* and *Ganoderma pseudoferreum* (*Fomes-pseudoferreus*).

Further investigations on the former at the Institute Experiment Station and on several estates, the results of which will be published shortly, indicate the possibility of infection by viable spores in contradistinction to the generally accepted ideas that all infection is by means of mycelium or rhizomorphs existing in the soil.

The beneficial effect of the removal of surface timber and jungle stumps would also appear to be problematical in relation to the incidence of the disease in young rubber up to three years of age.

The futility of treatment of the soil with heavy dressings of lime has also been demonstrated. Treatment with fungicides, especially copper sulphate, has been shown to be satisfactory, provided the fungicide comes into direct contact with the mycelium.

The results of the progress of recent investigations by the Pathological Division will be published shortly.

The occurrence of *Ganoderma pseudoferreum* on young trees has also been demonstrated. Formerly this disease had been discovered only on "mature" trees and its presence on young trees enables effective early treatment to be adopted. The spread of these diseases by direct root contact has been definitely established and thus enables infected areas to be satisfactorily treated, provided the inspection and treatment of lateral roots in such areas is carried out efficiently.

The investigations have also demonstrated the significance of root diseases and of *Ganoderma pseudoferreum* in particular as the limiting factor in the stand of old trees and shown that the re-planting of such areas with high yielding material is an economic proposition. A number of such areas on several estates have been re-planted and the results are being watched by the Pathological Division in relation to root disease and by the Botanical and Soils Divisions in relation to growth.
appendix.

Bark and Stem Diseases.

Mouldy Rot caused by the fungus *Sphaeronema fimbriatum* has again been very prevalent especially on small holdings and on estates bordering such holdings. The difficulties of treatment on small holdings has been enhanced by financial considerations, although the Agricultural Field Officers of the Department of Agriculture are doing their best to effect control.

At the request of the Director of Agriculture S.S. and F.M.S., an investigation of various proprietary fungicides is being carried out by the Pathological Division of this Institute with the object of preparing a "White List" of those fungicides which are found to be satisfactory for the treatment of this disease.

So far three new fungicides have been found to be satisfactory and only await a guarantee from the makers not to alter the formula,

before being added to the list. Formerly only Agrisol and Izal had been proved to be effective.

Leaf Diseases.

There was only a slight recurrence of the Mildew Leaf Disease caused by the fungus *Oidium Heveae* which appeared with some virulence during the dry weather after the normal "wintering" period of the rubber tree in 1930. The outbreaks were of such minor importance that it was not possible to carry out any extensive experimental spraying with sulphur dust which has been found to be the most effective treatment in Java and Ceylon. This may be described as fortunate in view of the financial situation of the industry and the cost of such treatment. A number of cases of Bird's Eye Spot Disease caused by the fungus *Helminthosporium Heveae* occurred chiefly on young plants and in nurseries, but control measures proved effective.

Insect Pests and Animals.

Till recently the only serious insect pest of the rubber tree has been the White Ant—*Coptotermes Gestroi.*

Mercuric Chloride treatment of the soil has been found to be a deterrent to the attacks of these insects but not a definite curative method of treatment.

Experiments on the application of Paris Green are being tried and indicate that this toxic substance is much more effective.

Mites in combination with a Gloeosporium fungus have caused damage, especially in nurseries on the young leaves of rubber tree seedlings.

A serious outbreak of a Cockchafer grub or caterpillar has however occurred over an area of about 80 acres on one estate.

Negotiations with the Government of the Federated Malay States through the Director of Agriculture have resulted in the loan of the part time services of the Government Entomologist of the Department of Agriculture for the investigation of this pest. Dr. Corbet of the Pathological Division of the Institute is now continuing the field investigations under the guidance and advice of the Government Entomologist. So far effective measures of control have not been discovered, but several promising lines of attack are being carried out.

Squirrels have again caused damage both to the branches and the tapped panel of the rubber tree on some estates, probably owing to lack of other suitable food. The only remedy for these pests is shooting.

Grasshoppers have caused damage on young plants and their presence is encouraged by cover crops. They appear to have shown special preference for the leaves of one particular clone.

Fungus attacks on Budded Plants.

Observations on several estates in relation to fungus attack at the union and on the pruned stock in the budding of large stocks of three years of age and over indicate that the asphalt-kerosene mixture recommended by the Institute as a wound dressing is not fully effective. This may be due partly to inefficient preparation of the mixture and lack of supervision in its application. Investigations however are being made in relation to the application of softer grades of bitumen and of waxes of high melting point containing sulphur as a fungicide. The principal fungi attacking such pruned surfaces are Die-back fungi and also the well-known wound parasite—*Ustulina zonata*.

Lightning Damage.

The effect of lightning in causing damage to individual trees or groups of trees has been demonstrated and also the relationship of such damage to cases of Die-back and claret coloured Bark Canker. A paper on this subject will be published later.

Chemical Investigations on Latex and Rubber.

Research work has been slowed up during the year owing to leave exigencies as indicated under " Staff " and in the Report of the Head of the Chemical Division. Satisfactory progress can however be recorded in several directions, especially in relation to the immediate requirements of the industry. It may also be emphasized that the improvements effected by the investigations carried out in relation to problems of immediate importance should lead to a greater uniformity in the raw product which is a problem of major importance.

Non-Caoutchouc Constituents of Latex.

The recent publication of articles in the Journal (Vol. 3 No. 3) dealing with the isolation and preparation on a semi-factory scale of Quebrachitol from latex serum and the influence of various sugars on the vulcanisation properties of raw rubber indicate the importance of the study of the non-caoutchouc constituents of latex. The possible commercial utilisation of quebrachitol is being investigated by the distribution of suitable consignments of this product among several chemical manufacturers and well-known organic chemists who have taken an interest in this product.

The importance of our work on the isolation of Lipin is also indicated by enquiries from Germany as to the date of the publication of our results in relation to certain patent applications in that country. Additional studies of this interesting substance in the Labo-

ratories of the Rubber Research Scheme (Ceylon), at the Imperial Institute have been made, while another investigator has demonstrated other properties, including its similarity to lecithin which is used for the prevention of blooming in chocolates and its effect in preventing the cohesion of raw rubber having a sticky surface. Although perhaps no direct use can be made of this product by its isolation from latex or raw rubber, its discovery may lead to the application of substances having similar properties.

The residual evaporated serum from a large volume prepared for the extraction of quebrachitol has been retained for further investigations of other possible useful constituents.

Preservation of Latex.

Investigations on methods of preservation of latex other than by the use of ammonia are being continued and the possibilities of the utilisation in various directions of latex preserved with the fixed alkalis—sodium and potassium hydroxide—are being explored. One large rubber manufacturing firm to whom consignments have been sent is interested in such latex.

It has been proved that potassium hydroxide is preferable to sodium hydroxide, especially if the latex is to be subsequently concentrated. This is probably due to the greater lubricating properties of the potassium soap formed by interaction with fatty acids present in the latex.

Several estates are now using compressed ammonia gas in cylinders for the preservation of latex in lieu of the strong ammonia solution (Liquor Ammon Fortis) imported in steel drums. Attention has previously been drawn to the dangers involved in using the latter liquid which is super-saturated with gas at the high tropical temperature in Malaya, unless special precautions are taken for cooling the drums and opening with great care. By passing the gas from cylinders direct into the latex to be preserved, the writer demonstrated several years ago that satisfactory results could be obtained, by determining the amount of gas absorbed by direct weighing of the cylinder and its contents on a weighing machine.

Much attention has been paid to the determination of the Dry Rubber Content of preserved latex and the importance of accurate mixing and sampling has been demonstrated.

A considerable amount of the ammonia imported also appears to be below strength, resulting in an insufficient quantity of ammonia being used for satisfactory preservation. The proportions recommended by the Institute should be amply sufficient.

Attention might also be drawn to the demand for latex containing 4 lbs. of dry rubber per gallon which is difficult to obtain on all estates and during all seasons. Provided that the dry rubber

content is not below 3.5 lbs. per gallon, such latex should be accepted by the market and purchased on the basis of its actual dry rubber content.

The discoloration of preserved latex due to the use of an excess of ammonia has also been demonstrated. This is probably due to the action of the ammonia on the containers and the formation of iron compounds.

Enquiries made on the use of an ammonia regulator for attachment to the cylinders of compressed ammonia have indicated that this apparatus, which is used for the application of ammonia in conjunction with chlorine for the purification of water supplies, is not likely to be of value quite apart from its cost.

It is of interest to record that the export of preserved latex is increasing and the Rubber Growers' Association has requested the Institute to collaborate in research in connection with methods of preservation.

Concentration of Latex.

The export of latex concentrated in centrifuges by the Dunlop Rubber Plantations Ltd., has continued. Revertex (latex concentrated by evaporation in the presence of a protective colloid) is now only exported from one estate in Johore; the estate on which the process was originated in Malaya has ceased to manufacture the product and has reverted to the preparation of smoked sheet.

Enquiries were made by Dr. Rhodes among several manufacturers of chemical plant for suitable apparatus for experimental investigations, but have not yet proved successful.

Attention is therefore being directed to methods of concentration by creaming and investigations are in progress. Several estates which are exporting latex are also interested in such methods from the point of view of increasing the dry rubber content of their latex.

Preparation of Smoked Sheet.

The preparation of sheet rubber in preference to thin pale crepe is related chiefly to the problem of cost of manufacture in the estate factory. Thin pale crepe requires expensive heavy machinery for its preparation and the output per battery is considerably less than that of sheet on relatively inexpensive batteries of light machines, even with the previous output.

It has now been demonstrated, as a result of the investigations of the Chemical Division, with the collaboration and assistance of various estate managers and estate factory superintendents who are qualified engineers, that outputs of 2,000—3,000 lbs. of dry sheet rubber can be obtained on the recently designed light sheeting

machines, erected in cascade or tile formation, in which the sheeting operations are continuous and the machines are not "running idle" while the operators are handling the coagulum. These outputs are from four to six times those previously obtained in the most efficient estate factories.

On one estate of 6,000 acres, a battery of six machines is now obtaining an output of 3,000 lbs. per hour, so that the factory machining of the day's crop is completed in about two hours.

Formerly on an estate of this area, at least four batteries in four separate small factories would have been installed to deal with the crop. Although, owing to slump conditions, re-organisation of factories is not possible on many estates, while others are too small to benefit by such outputs, it has been possible to effect considerably economies in cost of manufacture on smaller estates by comparatively inexpensive alterations effecting economy in labour and handling.

During the year the Chemical Division has been inundated with requests for advice and visits in relation to this problem and many managers have acknowledged the economies effected as a result of the advice given.

It may be emphasized that this work has been forced on the attention of the Institute by the exigencies of the situation and the necessity for reduction in costs. I have already indicated, however, its importance in relation to the more important problem of uniformity, which must result from the use of more efficient machinery, the centralization of factory operations and the bulking of larger quantities of latex.

More recent developments by a local engineering firm indicate that a battery consisting of one three-roll machine, two two-roll machines and a marking machine of two rolls may be as efficient as and cheaper than the battery of six two roll machines.

It may be remarked here that, in the past, little attention has been paid to this problem by the engineering firms which manufacture rubber machinery for estates. This is due, however, to the previous phenomenally high prices of raw rubber which have not necessitated such close attention to the question of costs and output.

Attention has also been directed to the problems of drying and smoking and it has been demonstrated that considerable economies in wood fuel and more rapid drying and smoking can be effected by attention to the thickness and evenness of the sheet, the ventilation of smoke-houses and smoke-house furnaces and the distribution of heat and smoke by the installation of more suitable types of smoke house furnaces.

On several estates the period of smoking and drying has been reduced from 10-12 days to 4-5 days. This not only results in economy of fuel but also in capital cost on smoke-houses.

In concluding this section, reference might also be made to the frequent occurrence of outbreaks of fire in smoke-houses during the year, which we have shown to be due to insufficient ventilation of smoke-houses and smoke-house furnaces, resulting in the accumulation of inflammable gases, which may be ignited by a spark.

For details of the results of these investigations, readers are referred to Manual No. 3 "Plantation Sheet Rubber Manufacture" recently published by the Institute.

Air-Dried Sheet.

It has not been possible to make much progress in our investigation of the problems of manufacture of air-dried sheet.

It may be stated, however, that one large company is now preparing this grade, while another estate, after smoking the wet sheet for 24 hours is completing the drying in a room heated by means of steam pipes.

Another aspect of this problem which is receiving our attention is the possibility of the preparation of a thin pale air-dried sheet as a substitute for pale crepe for the manufacture of pale transparent dipped goods.

Thin pale crepe is more uniform than sheet rubber, owing to the reduction of the non-caoutchouc constituents to a minimum by washing and machining and the more rapid drying which prevents biological changes in these constituents during the drying period.

We are of opinion that a thin pale air-dried sheet can be prepared from latex to which sodium bisulphite is added to produce the pale colour, which, by soaking in running water to remove the non-caoutchouc constituents, will be suitable as a substitute for thin pale crepe. Although the output may be only half that of a thicker sheet on the modern light sheeting batteries, it will still cost only about one third that of the preparation of thin pale crepe. If this can be effected, any estate equipped with light sheeting machinery and suitable drying rooms can prepare on demand either smoked or air-dried sheet for ordinary purposes or the special thin pale air-dried sheet as a substitute for pale crepe. This will eliminate the installation of heavy crepeing machinery except for the treatment of the 10-15 per cent. of lower grade rubber (tree scrap and lump, etc.) in a few central factories in each district.

Sole Crepe.

The manufacture of sole crepe still continues on a few estates, although the market price has dropped considerably owing to competition and the stabilisation of the demand, combined with the efforts of manufacturers to produce a higher quality of vulcanised

soles and probably in particular to the increased output of rubber footwear from Japanese rubber manufacturers.

Variability of Plantation Rubber.

A recent article published in the Journal (Vol. 3. No. 3) indicates that considerable variability still exists in plantation rubber not only between different estates but also on individual estates at different times which necessitates batching or mixing by the rubber manufacturer, in order to obtain a more uniform product.

Such variability cannot be distinguished by the buyer and is considered by some to be the cause of a decline in the demand for plantation rubber from estates.

The necessity for uniformity must be emphasized, if the plantation rubber industry is to compete successfully with substitutes such as reclaimed rubber and re-milled blanket crepe.

Statements have also appeared in the technical press on the subject of "pretty" rubber emphasizing the fact that the manufacturer is not interested in such rubber. Two factors, however, may be mentioned in this connection. In the first place, although it is realised that rubber of "pretty" appearance has no significance in relation to the intrinsic properties of the raw material required by the manufacturer, until the present methods of buying and selling raw rubber are altered, the average buyer will continue to pay a premium for clean rubber of good appearance. Marketing methods based on a knowledge of the intrinsic properties required by the manufacturer are therefore required to effect any change in this respect. Secondly, although "pretty" rubber may not possess the intrinsic properties which are of value, it does not necessarily cost more to prepare and also indicates better supervision and efficient machinery which is likely to result in greater uniformity.

Sheet with thick edges and corners due to lack of supervision and inefficient machinery costs more to prepare than sheet of regular and even thickness and appearance, and requires subsequent sorting and clipping which costs more and results in a lower price for the clippings.

Thin pale crepe is in a separate category since a pale even colour is wanted for the manufacture of thin pale transparent dipped articles, and colour and even appearance are therefore of importance.

The problem of uniformity of re-milled blanket crepe prepared in the re-milling factories in Singapore, in relation to the uniformity of plantation smoked sheet is receiving attention. From the estate producers' point of view, however, the re-milling of estate sheet, although it might result in greater uniformity, would cost more and the product would not necessarily fetch a higher price, on account of

greater uniformity, owing to present market methods of buying and selling.

During slump conditions which exist at present, the price of clean re-milled blanket crepe is likely to be much closer to that of the highest grades of plantation rubber on account of the available supplies. There is no reason to suppose that such re-milled blanket crepe is inferior to the best qualities of plantation smoked sheet, provided it is clean.

Our endeavours must however be directed to the production of special types of raw rubber to meet the specific requirements of the manufacturer, although, at present, ideas on this subject appear to be in a somewhat chaotic condition.

Some manufacturers state that they require a uniform but moderately fast curing and plastic rubber, others suggest a comparatively slow curing rubber, others indicate the importance of a more plastic product and state that variability in vulcanisation no longer presents difficulties, while, on the other hand, certain manufacturers still place emphasis on the variability in rate of vulcanisation.

The writer hopes to disentangle these apparent divergent opinions among manufacturers while on leave by personal contact with the technical representatives of the leading manufacturers.

Packing of Rubber.

Enquiries have been addressed to the Rubber Growers' Association suggesting that a questionnaire should be sent to all the leading rubber manufacturers in Europe and the United States of America on the subject of requirements in relation to packing of rubber with the object of substituting other packing materials for the wooden cases now generally used.

A number of large manufacturers pack rubber required for their own factories in hessian treated with a mixture of tapioca starch and sodium silicate.

The treatment of the hessian is with the object of making the fibres cohere, so that they do not adhere to the rubber. Since all rubber is now wrapped in a layer of rubber similar in quality to the contents of the case, any contamination only affects the wrapper layer. The total cost of packing in treated hessian amounts to only 0.13 cents per lb. compared with 0.38 cents per lb. for wooden cases costing 85 cents each (exclusive of cost of labour of making cases from the imported material). The suggestion to ship rubber wrapped only in a layer of rubber with suitable strapping, is not recommended, since the lower bales in the hold of a ship are likely to become massed together by the weight of superimposed bales and will probably be difficult to separate on arrival at their destination. Some non-rubber wrapping is essential. Experiments are being carried out

with special wrapping papers but it is considered that such papers are not likely to be sufficiently strong for the large heavy bales.

Hessian, treated as described above, has however been used by several producers for some years and found to be satisfactory.

It is also possible that a useful local industry could be developed by the use of matting prepared from Mengkuang, as used for baling tobacco leaf. No figures of cost are however available.

Rubber Roadways Investigations and New Uses for Rubber.

As a result of discussions late in 1930 between the Hon'ble the Chief Secretary to Government, Federated Malay States, the President of the Board of this Institute and the Director, it was decided that investigations should be initiated at the Institute re the application of rubber, particularly in the form of latex to roadways.

It was agreed that such investigations could best be carried out in this country and that in the first instance chemical investigation was essential before any practical trials by road engineers could be carried out.

The Board of the Institute adopted the recommendations put forward for this investigation and agreed to allocate funds and to appoint a Chemist to undertake the work. A special sub-committee, entitled the Rubber Roadways Sub-Committee, consisting of the President and other members of the Board, a representative of the Public Works Department, F.M.S. and the Director of the Institute was formed to control the investigations. A contribution was also granted by the Rubber Experimental, Research and Propaganda Fund Advisory Board, F.M.S. for any practical road trials of promising products which might be prepared.

The Public Works Department, F.M.S. has agreed to co-operate in any large scale trials which may be carried out.

Investigations were commenced in March, 1931, by Dr. E. Rhodes of the Chemical Division, and a Temporary Chemist—Mr. J. D. Hastings was appointed and assumed duties in May, 1931.

A separate report by the Chemist appointed in 1931 to investigate in particular the possibilities of rubber roadways products by the use of latex in admixture with suitable ingredients such as asphalt or bitumen and cheap inert fillers is attached to the report of the Chemical Division in order to indicate the progress made in these investigations.

Experiments with bitumen emulsions and latex, including Colas and a product known as Aleric received from England, indicate that these present no special advantages when used as a road dressing only. The mixture when applied flakes more readily than the dressing of the pure bitumen emulsion alone.

When mixed with other ingredients to form a paste for spreading in order to make a resilient surface layer, the chief disadvantage which such mixtures present is the extensive cracking. As a result of the formation of a waterproof surface film or skin and the evaporation of the water in the compound under the strong tropical heat of the sun, cracking develops. Under laboratory conditions such mixtures appear to be satisfactory. Further experiments with other fillers to absorb the moisture and allow it to escape more slowly are being carried out.

It is also proposed to investigate the possibilities of dry raw rubber and to prepare emulsions of dry bitumen with latex in order to reduce the water content. Products prepared and pressed in the laboratory might be suitable for building purposes or for insulation.

The use of concentrated latex, unless prepared by a cheap creaming or centrifugal process is considered to be too expensive, in view of our knowledge as to the cost of methods of concentration by evaporation. A rubber sheet about 1 inch thick, containing over 40 per cent. of raw rubber and a cheap filler such as kaolin, manufactured by the Kinta Rubber Works, would appear to be promising, especially in special areas or as a pavement surface. The cost of this material is considerably less than that of the various rubber capped blocks on the market. A trial stretch has been laid for over a year on a second class road in Perak and recently a small section has been laid by us on a road on which the local traffic is heavy.

Investigations on the application of latex in the preparation of paints and distempers bear a close relation to the preparation of emulsions of latex with other products and are being investigated in collaboration with the Singapore Rubber Works which has already placed such products on the market.

A number of ideas for new uses of rubber are from time to time submitted to the Institute for our opinion and advice. In addition to giving enquirers our own opinion, based on our knowledge of the rubber manufacturing industry, all such enquiries are referred also to the New Uses Committee of the Rubber Growers' Association, London, for confirmation or otherwise of our opinion.

During the year, no special ideas involving any important new application have been received. We welcome, however, the receipt of any new ideas and are always ready to give enquirers our opinion on these.

It may be desirable to state here, however, that the technical literature which we receive at the Institute contains numerous references to new applications of rubber, but only comparatively few of these are of particular importance in absorbing more of the raw product.

Considerable investigation by manufacturers is in progress, especially in relation to the application of latex to present and also to new uses. This is indicated by the increasing export of preserved latex.

Mention might be made here of the proposal for the preparation of rubber oil by the dry or destructive distillation of raw rubber, and the utilisation of the oil as a substitute for turpentine and for various solvents. The possibilities of this process were examined during the previous Restriction period.

The conclusion has been reached that the process is not economical unless raw rubber is available at what might be described as an unremunerative price or unless free supplies of surplus rubber could be utilised.

This conclusion has been confirmed by several well known chemists in Great Britain to whom the proposal has since been submitted by the Rubber Growers' Association.

The views of the writer in relation to New Uses are expressed in a lecture delivered at the Annual Conference of the Incorporated Society of Planters held in 1931 (See "The Planter" Vol. XII No. 2 September, 1931. p. 52).

Rubber Patent Applications.

Applications for Grants of Exclusive Privileges for inventions in relation to rubber processes, machinery and equipment, under the Inventions Ordinance of the Straits Settlements and the Inventions Enactment of the Federated Malay States are now referred by the respective Governments to this Institute for report.

During the year 25 applications from the Federated Malay States and 11 applications from the Straits Settlements have been received, examined and reported on.

Several have been rejected on the grounds of lack of novelty, prior use, or knowledge or as not complying with the legal requirements.

FIELD DIVISION.

A Field Officer has been stationed in Johore throughout the year and his report is attached.

Quarters were secured for this Officer with accommodation for an office in the quarters.

Arrangements have also been made for the allocation of a Field Officer to Province Wellesley, Kedah, Kelantan and Trengganu.

Suitable quarters have been acquired from the Penang Rubber Estates Ltd., on Caledonia Estate, Nibong Tebal, Province Wellesley together with an adjoining laboratory and office which will be avail-

able for the use of this Officer. Owing to various circumstances this Field Officer was not allocated until early in 1932.

For the greater part of the year there was only one Field Officer at Headquarters who relieved various Divisions of a certain amount of advisory correspondence and visits and was detailed to take visitors to the Experiment Station.

Owing to leave exigencies in the case of both research and field officers it was not possible to send an officer to Kelantan or Trengganu during the year, but arrangements have now been made for periodical visits to these more isolated States.

The allocation of two Field Officers to the extreme southern and northern portions of the peninsula respectively will not only save expense in travelling and time of officers from the Headquarters in Kuala Lumpur, but will be valuable in keeping the Institute in closer touch with planting problems in these districts. This has already been demonstrated in the case of Johore.

Copies of all advisory letters sent to estate managers or other enquirers by these officers are forwarded weekly to Headquarters, so that the Director and Research Officers can keep in touch with the various problems on which advice is given. When the Field Officer is unable to give advice, reports are forwarded by him to the Institute, which are of value in enabling the Heads of Research Divisions to advise. Monthly reports are also forwarded by these Field Officers for the information of the Board and the Director.

Estate Visits.

The total number of visits paid to estates during the year by officers of the various Divisions is as follows:—

Botanical Division	...	176
Chemical Division	...	222
Pathological Division	...	214
Soils Division	...	55
Bacteriologist	...	3
Chief Field Officer	...	16
Field Officer, Johore	...	161

The visits under Botanical Division include 94 visits to Pilmoor Estate in connection with tapping experiments on Pilmoor Estate clones.

Visits by officers to the Institute Experiment Station are not included in the list.

Experiment Station.

The Report by the Manager of the Experiment Station indicates the progress made during the year.

No further area has been opened from the jungle reserve, but the present opened area has been almost completely planted up.

The re-arrangement of certain blocks formerly allocated to the Pathological Division has enabled the programme of the Botanical Division to be carried out on the present opened area, without interfering with observations and records required by the Pathological Division.

Two five-acre blocks in the Forest Reserve adjoining the Experiment Station, were acquired on lease, through the courtesy of the Director of Forestry, S.S. and F.M.S., for certain experiments with *Hevea Spruceana*, which it was desirable to isolate from the Station.

Owing to the more regular rainfall and the extension of the lateral root system of the trees, good growth has been noted on nearly all blocks during the year. After the trees have reached a certain development, the effect of drought in causing stagnation of growth is not noticeable.

A revised Guide, containing details of the various experimental plots, including the history of the plots since opening to the end of 1931, has been prepared.

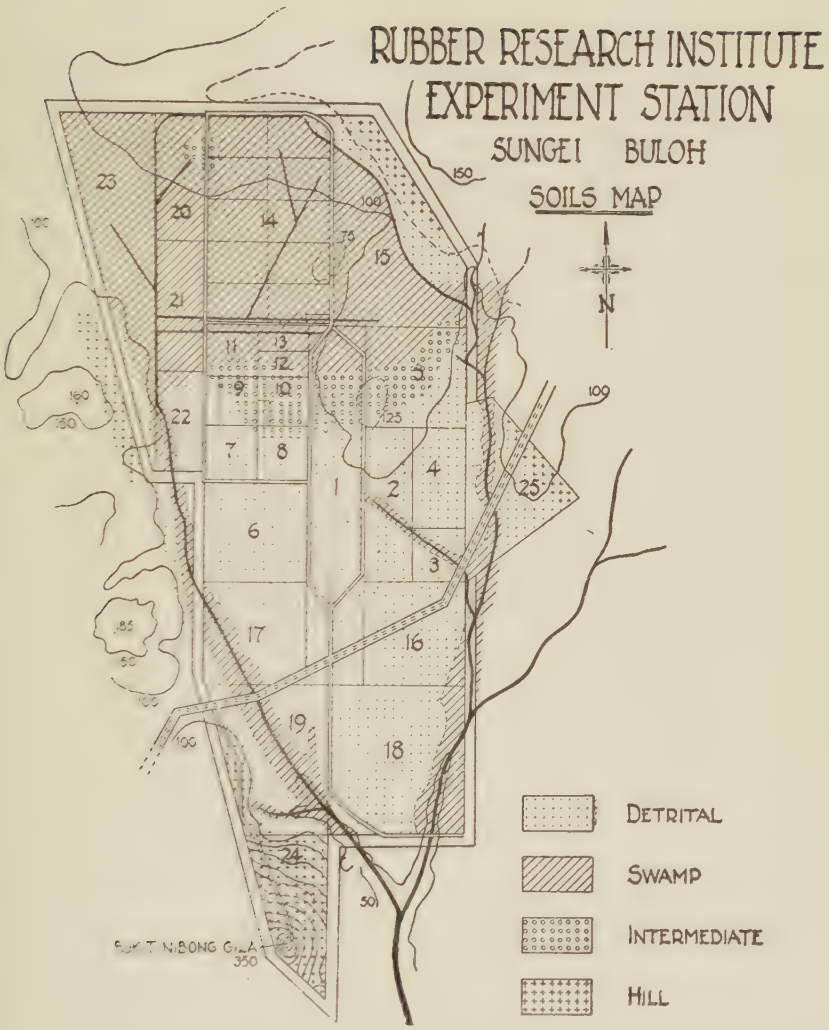
In addition to the map shewing the lay-out, a soils map has been prepared by the Soils Division to illustrate the three main soil classifications on the opened area. Both maps are included in this report (see page 50—51).

Area and Lay-out of Station.

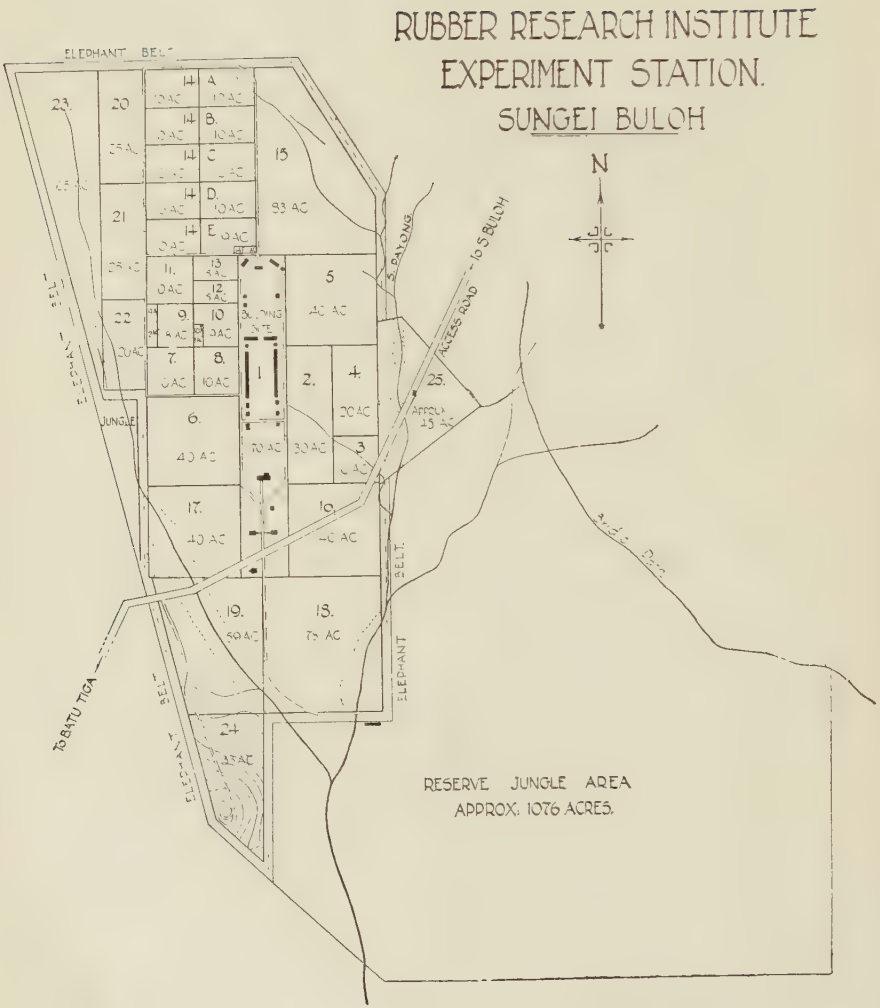
The total area of the Experiment Station is 2055 acres which includes 989 acres already opened and 1066 acres of reserve jungle.

The following is a summary of the various experimental blocks. A comparison of these with the summary given in the Annual Report for 1930 will indicate any changes which have been made, especially in relation to the re-organisation and allocation of the Pathological Blocks.

Block No.	Area (Acres)	Area planted (Acres)		Details of Experiment.
1	70	—	...	Building Site (Manager's and Assistant's Bungalows, Guest House, Field Laboratories, Conductor's Quarters, Dispensary, Shop, Coolie Lines, Store Buildings, Hostel for Conductors, Engine and Dynamo House, etc.), Multiplication and Seedling Nurseries. Grazing ground for cattle.
2	30	30	...	Collection of trees raised from seed from "historical" trees in Malaya, Ceylon and Java. Tjikadoe seed from Anglo-Dutch Plantations, Java. Subsequently interplanted for budding.



Note:—The swamp areas after having been drained are all suitable for planting.


RUBBER RESEARCH INSTITUTE
EXPERIMENT STATION.
SUNGEI BULOH
N
ELEPHANT BELT
ACCESS ROAD TO S BULOH
S. PALONG
JUNGLE
RESERVE JUNGLE AREA
APPROX. 1076 ACRES.
TO BATU TIGA

Block No.	Area (Acres)	Area planted (Acres)		Details of Experiment.
3	10	10	...	Buddings from cross pollinations of Pilmoor Estate Clones (1928) taken from seedlings in Block 4A.
4A	10	10	...	Variability Trial (5 acres North). Pilmoor Estate Crosses (1928) (5 acres South).
4B	5	5	...	Nursery for Budding work and Multiplication.
4C	5	5	...	Twin seedlings for Stock and Scion Experiments. (2½ acres North). Comparison of Seedlings and Stump planting. Used for Test-tapping Experiments (2½ acres south)
5	40	40	...	Clone Trial Plot for comparison of 9 Malayan, Java and Sumatran Clones.
6	40	40	...	Manurial Experiment on ordinary seedling material. Five separate treatments with control plots—replicated six times=36 plots.
7	10	10	...	(i). Incidence of *Fomes lignosus* under surface cleared and uncleared conditions. (ii). Incidence of *Fomes lignosus* under cover crops and clean-weeded conditions.
8	10	10	...	As per Block 7, but surface timber cleared. 200 trees budded from high yielding trees suffering from Brown Bast.
9A	2	2	...	Left fallow for 5 years : clean-weeded after felling and burning. (i). To test rate of decay of jungle timber. (ii). Incidence of *Fomes lignosus* under above conditions.
9B	8	8	...	(i). Comparison of incidence of *Fomes lignosus* under cleared and uncleared conditions. (ii). Comparison of progress of root disease in treated and untreated areas.
10A	1	.1	...	
10B	9	9	...	(i). Comparison of seedlings budded at different heights from ground level to 4 feet with five different clones. (ii). Comparison of green, intermediate and brown budwood.
11	10	10	...	"Forestry method of Cultivation." Secondary growth (Belukar) allowed to develop. Planted with basket plants, stumps and seed at stake. Eastern half slashed twice yearly. To determine influence of secondary growth on growth of the rubber trees and also incidence of root disease.

Block No.	Area (Acres)	Area planted (Acres)		Details of Experiment.
12	5	3	...	Nurseries for various experiments. Treatment of leaf diseases ; treatment of pruned surfaces with wound dressings ; application of soil disinfectants ; budding.
13A	2½	2½	...	Cover Crops. Demonstration Plots.
13B	2½	2½	...	Cover Crops growing under Rubber.
14A&B	20	20	...	Buddings from 1929 Crosses of Pilmoor Estate Clones from Block 16.
14C&D	20	20	...	Density Planting of Budded Rubber trees. Clone AVROS. 50.
14E	19	19	...	Crosses and Controls (1931) from various pollinations. Stumps selected by using Cramer's Test-tapping knife.
14F	1	1	...	To determine growth and incidence of disease on area from which felled jungle was removed without burning.
15	83	80	...	Clone Collection. Plants budded from high yielding Malayan mother trees and new clones interplanted with Clone AVROS. 50 as control. Buddings already established from 34 clones and 150 high yielding trees.
16	40	35	...	(a). Pilmoor Estate (1929) Crosses and Controls. (b). Estate selected tree families for study of variability. 2½ acres reserve for Factory Site. 2½ acres Road Reserve.
17A	43	43	...	(i). Manuring with complete organic fertilizer and with magnesium sulphate at intervals. (ii). Comparison of above treatment under cover crops and clean weeding. (iii). Mixed planting of buddings (six clones).
17B			...	Nurseries for General Experiment. Nurseries for Mulching Experiment.
17C			...	(i). Natural Covers (grasses) and Cultivation Experiments. (ii). Budding. Duoclone system with "proved" clone and promising new clone. (iii). *Fomes lignosus*. Experimental treatments.

Block No.	Area (Acres)	Area planted (Acres)		Details of Experiment.
17D			...	(i). To determine effect on soil of 10 cover crops under rubber. (ii). Mixed planting of buddings (six clones)
18	78	73	...	To test various tapping systems on buddings.
19	55	53	...	Budded with clone BD. 5. (i). Natural Covers (grasses) and Cultivation. (ii). Incidence of Root disease in "swamp" area.
20	25	25	...	Duoclone Budding. Manurial Experiment with Perlis phosphate (1931).
21	25	25	...	(i). Polyclone budding. (ii). Various Cover Crops.
22A	3	3	...	Area dug to 3 feet-depth and completely cleared of all buried and surface wood. To determine incidence of Root disease.
22B	10	10	...	Non-Hevea latex yielding plants for study of latices.
23	65	65	...	Effect of certain Catch crops on growth and yield of Rubber Trees. (Tapioca, Pineapple and Coffee).
24	33	33	...	Hill Area. Soil erosion on hill land. Covers, terracing and bunding. Selected strips under different treatments for measurement of soil erosion.
25A	40	40 (Approx)	...	Selection Experiments (1930) Crosses and Controls. Budded stumps from (1928) Crosses.
25B	5	5 (Approx)	...	Material from Malayan selected seed and clones. Twin plants for Stock and Scion Experiments. Nurseries in Ravine for budding Experiments.
Jungle Plot A	5	5	...	Experiments with *Hevea Spruceana* to obtain seed for stock purposes. Buddings of *H. Spruceana* are made on *H. Brasiliensis* Stock.
Jungle Plot B	5	5	...	*H. Spruceana* buddings mixed with *H. Brasiliensis* buddings. To obtain hybrid seed for budding purposes.

Conferences and Lectures.

The following lectures were given at the Annual Conference of the Incorporated Society of Planters at Port Dickson :—

"Recent Advances in the Application of Rubber to New Uses" by B. J. Eaton.

"Root Diseases in Mature Rubber Areas" by A. Sharples.

"Rubber Estate Factory Organisation" by R. O. Bishop.

In addition the following lectures were delivered before various branches of the Incorporated Society of Planters, District Planters' Associations and other Organisations :—

Subject.	*Venues.*	*Lecturer.*
Factory procedure and Handling and Drying of Sheet Rubber.	I. S. P. Muar Branch.	E. Rhodes.
Present Position of Selection of Hevea.	do. do.	L. E. Morris.
Budding.	N. S. Planters' Association.	C. E. T. Mann.
Factory Organisation and Equipment.	I.S.P. Nilai Branch.	R. O. Bishop.
Further Advances in Factory Procedure and the Drying and Handling of Sheet Rubber.	I.S.P. Taiping.	R. O. Bishop.
Problems of Root disease in Old Rubber.	do. do.	A. Sharples.
The Trend of Modern Research and its Application to Planting Practice.	I.S.P. Taiping.	B. J. Eaton.
do. do. do.	I.S.P. Ipoh.	B. J. Eaton.
Estate Factory Methods and Manufacture.	I.S.P. Kuala Selangor.	B. J. Eaton.
Factory Organisation.	I.S.P. Kajang.	R. O. Bishop.
Curing Costs.	Malacca Planters' Association	R. O. Bishop.
Plantation Rubber and its Cost of Production.	Rotary Club, Singapore.	R. O. Bishop.
Preparation of Rubber in Estate Factories.	Conference of Managers of Estates under Agency of Sime Darby & Co.	R. O. Bishop.
Budding and Variation.	do. do.	L. E. Morris.

A Visit to Russia.	Rotary Club, Kuala Lumpur.	W. B. Haines.
Spectroscopic Analysis.	Institute of Chemistry, (Malayan Section) Kuala Lumpur.	C. F. Flint.
Rubber-Research on Production.	Centenary Meeting of the British Association for the Advancement of Science.	B. J. Eaton.

At the request of Sir John Russell, D.Sc., F.R.S., Chairman of the Agricultural Section of the British Association for the Advancement of Science, a paper entitled "Rubber-Research on Production" was presented by the Director of the Institute at the Centenary Meeting of the Association held in London. Dr. H. A. Tempany, Director of Agriculture, S.S. & F.M.S., who was on leave, kindly gave an abstract of the paper at the meeting.

Publications.

The following publications were issued during the year :—

1. Annual Report 1930.
2. Journal of the Institute, Vol. 2 No. 4 and Vol. 3 Nos. 1 and 2 (Vol. 3 No. 3 Issued March 1932).
3. Bulletin No. 3. "The Root Disease Problem on Old Rubber Areas in Malaya" by A. Sharples.
4. Bulletin No. 4. "Summary of Meteorological Records, Soils Division," by W. B. Haines.
5. Manual No. 3. "Plantation Sheet Rubber Manufacture" (Issued February 1932).
6. Information Cards on the Preparation of and Defects in Raw Rubber (Nos. 17C to 21C).

A revised Guide to the Experiment Station, containing a map showing the various experimental blocks and a soils map, together with notes on the history of all the blocks was prepared. This Guide is at present issued only to Members of the Board and the London Advisory Committee and used for visitors to the Station. At a later stage it may be found desirable to issue the guide in a printed form.

Exhibitions.

The only Exhibition in which the Institute was requested to take part during the year was the Annual Exhibition of the Malayan Agri-Horticultural Association held in Kuala Lumpur during the August Bank Holiday.

The Director was Chairman of the Rubber Section Committee and nearly all members of the Staff devoted much time and attention to making the Section a success.

Although approximately 2,000 rubber estates were circulated by letter and invited to support the Exhibition by sending rubber for competition only 65 rubber exhibits were received which included 50 samples of smoked sheet, 2 samples of pale crepe and 13 samples of lower grade crepes.

In spite of the comparatively small number of exhibits from large estates, those received were generally of excellent quality. An excellent collection of smoked sheet was exhibited by members of Small-holdings' Co-operative Societies. It should be mentioned that all the exhibits from the largest estates consisted of commercial samples selected at random from cases in the estate factories. Kirby estate also exhibited an excellent range of coloured sole crepe (not for competition).

The success of the Section however was assured by the instructive exhibits staged by the Institute.

Particular mention should be made of the excellent models of estate factory aluminium equipment presented to the Institute by Diethelm & Co., Singapore, through the Director—Mr. H. Schweizer, and the model sheeting machines in cascade or file formation constructed by the Federated Engineering Co.

These models enabled the Chemical Division of the Institute to stage a model lay-out of up-to-date factory equipment and machinery for the preparation of sheet rubber. The machines were operated by means of a small motor.

A special drying chamber heated by means of low voltage electrical heaters was also exhibited. Thanks are due to the Government Electrical Department, F.M.S., for their assistance in the installation.

An attractive exhibit of Cressonite floor and wall tiles was presented to the Institute for exhibition by the Singapore Rubber Works, while Messrs. Tan Kah Kee sent an excellent exhibit of their manufactured rubber goods for competition in the Section for locally manufactured rubber articles. The Rubber Section is also indebted to the Dunlop Rubber Co., for a Show Case containing specimens of various manufactured articles including the new sponge rubber cushions manufactured direct from latex.

These exhibits, together with numerous specimens of special types of raw rubber, including excellent samples of air-dried sheet from Kamuning Estate and Socfin Co., Ltd. and samples showing various defects and photographs attracted much attention. A very comprehensive exhibit of rubber tree diseases was staged by the Pathological Division, also exhibits and photographs by the Botanical Division

illustrating budding operations and a series of young plants of well-known clones illustrating important vegetative characters for the identification of these clones. Demonstrations of budding were also given at intervals during the Exhibition. The Soils Division concentrated on a valuable technical exhibit illustrating the main classifications of soils on a climatological basis.

Officers of the various Divisions were on duty throughout the Exhibition to give advice and information. The Rubber Section was considered to be an unqualified success.

Visitors.

A feature of the year, as during previous years, has been the large number of visitors, especially planters, who have visited the Institute and Experiment Station. These have shown a considerable increase over previous years.

Special visitors include :—Hon'ble Mr. J. W. Simmons, British Resident, Selangor, Mr. F. D. Ascoli, C.I.E., Managing Director, Dunlop Plantations Ltd., London, Mr. Rafael Aluman, Secretary for Agriculture and Natural Reserves, Philippine Islands, Dr. P. J. S. Cramer, Mr. H. W. McGowan and Mr. H. J. Page, M.B.E., Imperial Chemical Industries (England), Mr. F. R. Cawley, Resident Magistrate (Territory of Papua), Dr. F. P. Ferwerda, Selectionist Bij's Lands Caoutchoucbedrijf, Buitenzorg, Java, Mr. J. B. Ingle, Managing Director and Dr. Weir, Director of Research, Goodyear Plantations Ltd., (Sumatra), Mr. F. W. Macguire, Director of the Caledonia Group of Estates (London), Mr. A. L. Mathewson, Director Harrisons and Crosfield (London), Mr. John Mitchell, Director of Malayan Rubber Companies (London), Mr. Maus, Director, S. I. P. E. F. (Antwerp), Mr. J. L. McKnight, c/o B.F. Goodrich Ltd., Akron, Ohio, Mr. Jackson, Deputy Manager, Anglo-Dutch Rubber Estates, (Java), Messrs. Keith Bon and R. Prior, Rubber Trades Association (London), Mr. M. Malye, Plantations Michelin, Indo-China, Dr. Reibl, Chief Chemist, Central Rubber Proefstation, Buitenzorg (Java), Dr. Rosedale, Professor of Bio-Chemistry, College of Medicine, Singapore, Mr. F. Siddall of Francis Shaw and Company (Rubber Machinery Manufacturers, Bradford, Manchester, England), Prof. Stakman, Professor of Plant Pathology, University of Minnesota (U.S.A.), Mr. Donald W. Smith, U.S.A. Department of Commerce, Singapore, Dr. Whitford of the Rubber Manufacturers Association of New York, and Mr. Georges Wormser, Syndicat des Cultivateurs de Caoutchouc de Cochin Chine, Saigon.

General.

Acknowledgments.

I wish to express my thanks to members of the Senior and Junior Staff for their loyal support during the year. Many officers

both of the Senior and Junior Staff have willingly devoted many extra hours outside the normal office hours to cope with the increasing work.

I wish also to express my grateful thanks to the numerous Managers of estates and Factory Superintendents for their cooperation and collaboration, without which the work of the Institute could not be carried out so effectively.

Replies to questionaires and records from estates are of considerable value to research officers and frequently save considerable time and effort in the elucidation of various problems.

(Sgd.) B. J. Eaton,
Director.

ANNUAL REPORT

SOILS DIVISION.

The Head of Division assumed duty on the 1st March after home leave and for the rest of the year the staff was at full strength.

The slump conditions have, for obvious reasons, led to some falling off in the amount of advisory work on soils questions and also to some changes in the main lines of interest. The analysis of correspondence given in the Appendix when compared with that of the previous year shows a drop in numbers of letters to about 60 per cent : enquiries on manuring fell to one third the previous number, but enquiries on cultivation and covers were more than doubled. The figures do not include the large number of special reports and memoranda prepared.

The number of Estate visits made was 60, which shows only a small falling off from last year. The same number of visitors called on the Division for interviews on special matters. On an average three visits per month were made to the Experiment Station.

Routine Analysis.

The number of samples received during the year was 369, of which 347 were soils. The routine work on these samples involved a total of 2,742 analytical determinations.

Several samples of the ash from the furnaces of copra kilns were sent in, with enquiry as to their fertilising value. A typical sample showed 30.2 per cent of potassium and 0.63 per cent of phosphates and consisted, in fact, very largely of potassium carbonate. It has, therefore, a high value only as a potash fertiliser and not as a balanced fertiliser. It should prove of value on most soils, and cover crops might often benefit from its application. Owing to its extremely caustic nature it must be applied with the utmost care, using small quantities on each occasion and distributing carefully by first dissolving in water or grinding and mixing with dry sand or earth.

A case for special enquiry arose toward the end of the year where an area of young rubber suffered an inundation from the sea by reason of an exceptionally high tide. Samples of water showed that the inundation was undiluted sea. Soil samples taken immediately showed 0.54 per cent of sodium present. This had been reduced by the natural effect of rain in a few weeks to 0.15 per cent in the surface soil. From this point onward leaching was slow. The subsoil was more slowly affected but continuously improved. It is concluded that the death of the trees was due to the

shock of a sudden change in the soil solution rather than the creation of impossible growing conditions, and that replanting could be undertaken with success. Some of the trees were saved by the prompt action of removing the soil round the roots and replacing with undamaged soil, but this was only effective on the trees treated quickly. From the amount of sodium present and the composition of sea water it can be calculated that quantities of potassium, magnesium and calcium far in excess of ordinary manurial applications (*e.g.* 14 times as much in the case of potassium) must have gone into the soil with the common salt. It is not remarkable, therefore, that the inundation had a great influence on the yield records from the older rubber which was affected, though it is remarkable that the older trees should stand without injury such a drastic and sudden change in the soil solution around their roots.

Samples of soil sent in are almost wholly selected from poor areas and so do not form a satisfactory basis for any broad systematic study. For this purpose, therefore, typical soil profiles under rubber are being examined, about 20 having been finished during the year. The climatic conditions of high temperature and high leaching impose certain chemical similarities upon most of the cases, which brings physical differences into prominence. One of the major differences which may be emphasised is depth of soil. Situations which have been characterised by good growth and sustained yield in the stand of trees, usually owe this to a good depth of porous well-drained soil giving unrestricted root-range. No other single factor is so important.

Manuring.

A summary of results of manuring was published during the year, so that little further comment is required. Owing to the generally disappointing results in old rubber, and the expectancy that the price of rubber is not likely to be stabilised at a high figure (in relation to the price of fertilisers), manuring for rejuvenation seems likely to recede into the background. Its place as an integral part of replanting schemes, however, seems likely to stand. Recently published results and conclusions from Java lend strong support to these views.

Forestry System of Planting.

It is a pleasure to record the fact that interest during the year has very much increased in the subject of replacing the cultivation methods of the past (viz. strict control of all weeds) with more natural methods suited to the needs of a forest tree. The Division has done all in its power since its inception to inculcate a proper

understanding of the forest cycle as the basis of the ideal conditions for growing rubber. The enterprise of Mr. Birkemose of Shanghai Pahang Estate, Bentong has applied such ideas for some years to areas under his control and has given us a clear example of what may be accomplished. A short description of one experiment will be attempted here. Although it is not altogether in place in this Report, the present interest in the subject is sufficient excuse for giving it space.

The area of outstanding interest is a hill top which has been remarkably regenerated by Mr. Birkemose in a very short space of time. It was originally planted in 1918 from secondary jungle of some eight years' growth. Rather wide spacing of the trees was adopted, which has some bearing on the subsequent history ; intervals of 15 feet along contour paths were laid out with 30 feet between each. At the start Tephrosia was tried as a cover crop but unsuccessfully, and the hill was then clean weeded for the next five years. The soil became baked and washed and the trees began to show signs of stagnation. Stagmoss and ferns were allowed to form a natural cover from 1923 onwards and had formed a complete carpet by 1928. The trees went from bad to worse during this time and stood with bare and dead branches. Tapping took place between 1924 and 1927 but was then stopped owing to untappable bark conditions, and the hill was abandoned. At this point (November 1928) the regeneration was taken in hand. Stagmoss, ferns and bracken were taken out by hand (to avoid root injury to the rubber) and spread evenly over the ground. Rubber seeds were then broadcasted perseveringly at each seeding season. On the first two occasions there was germination but the seedlings were unable to establish themselves. Gradually, however, success was achieved and early in 1930 a full cover of seedlings protected the soil. Where dressings of lime were given the processes were apparently assisted. Recovery of the main stand went hand-in-hand with the establishment of this seedling cover, and the soil gradually assumed a soft open texture. The writer first saw the area in the middle of 1931 when the trees were carrying vigorous and healthy foliage, although the traces of the late conditions of Die-back could easily be seen. Tapping was resumed in 1930 and the monthly yields during the latter part of that year and the beginning of 1931 gave rates varying between 600 and 800 lbs. per acre per annum, with every indication present that conditions were stable and would be maintained. The most vigorous seedlings have now been selected and budded with the intention of finally replacing the older stand with this new stock. These buddings have made a most excellent start in their "forest" surroundings.

The results are impressive and give sufficient proof of the soundness of the principles involved. Owners must be warned, however,

against assuming too readily that such rapid response can be generally expected. A radical change in cultivation policies is undoubtedly called for and will lead to steady improvement in a majority of cases. It must obviously be better to work with natural tendencies under suitable control than to fight them as is done in clean weeding. In this particular case we have to consider the young age of the trees, the original open stand, and the rapidity of the deterioration which took place, in relation to the rapid recovery. The rate of response in other cases will be modified by the difference in the original conditions, notably by the set stagnation in bark renewal of old trees which have been tapped under starved conditions for many years. The slow responses under manuring can no doubt offer some analogy here, though close comparison is not justifiable. Years of exposure by clean weeding usually reduces a soil to extreme poverty in organic matter and therefore in micro-organic life, and the process of regeneration consists in restoring these. Absence of viable seeds of wild plants is another typical consequence. The process of restoration, if left entirely to nature, begins with a cover of vegetation of one or two species only, which establish themselves by virtue of special advantages in their means of feeding or of propagation. Lallang grass, stag-moss, bracken and "Straits rhododendron" (Melastoma sp.) are usually the first to appear under old rubber. In the process of time, as organic material is again built up and shade improves the moisture and texture of the soil, the cover diversifies. The succession of floral species is accompanied no doubt by important similar changes in the soil population of micro-organisms. Not until the nitrogen fixers become active will the best evidences of improvement be manifest. The aim of good management must be to hasten this succession of events by suitable control. The steps may be summarised as follows.

(1) Organic matter is first built up by allowing all weeds except lallang to grow. During this stage the weeds will compete with the rubber for their food and no marked improvement in the rubber can be expected.

(2) Selective weeding by hand pulling is begun, the return of organic matter to the soil being thus hastened by laying the debris close to the surface. Dressings of lime will assist decomposition and prepare the way for germination and growth of the more suitable plants. Weeding should never be severe enough to remove shade from the soil.

(3) Selection will be placed on a sound basis as experience is gained, but it is evident that the subject must be approached tentatively. Hard and fast rules can hardly be laid down until the material to be worked on has appeared in each particular case. Plants which maintain acid conditions round their roots, those which form thick and matted root systems, and those which tend to become woody

when mature are all suppressed in favour of more sappy and broad leaved plants. As an index of final improvement the so-called "nitrate feeders" appear, being characterised by soft vivid green leaves and delicate tissues generally.

The ideal aimed at is a moist shaded soil in a high state of activity. It is to be noted that a high rate of decay of organic debris means small accumulation, and relatively bare conditions at the soil surface itself. Conversely the accumulation of a thick layer of undecomposed debris on the soil has no special virtue, but is an indication of slow decomposition. Where natural covers have been allowed to grow without good results accruing it will generally be found that these latter conditions are responsible.

The value of the rubber seedling in the early stages of such methods of regeneration has been clearly demonstrated. Its place in the final stabilised natural cover has yet to be worked out. So far the discussion has been limited to methods easily combined with established systems of management, applicable to policies of the moment. A complete reversion to forestry methods, where the self sown "cover" of Hevea is reared for the replacement of successive generations, cuts so deeply at the present organisation of collection and supervision that its further discussion is here out of place. Its claim, however, for careful consideration from every angle can hardly be over emphasised.

Laboratory Researches.

Measurements and observations have been conducted on two seedling culture experiments, one of which is still continuing. The stunting effect of deficient nitrogen was demonstrated very clearly, but so far the effects of mineral food deficiencies have not been marked. This may be due to the prolonged effect of the small quantities of all food constituents which had to be given to start the plants, or it may be due to the difficulty of finding sufficiently pure sand. Elucidation of these technical points will pave the way for a more satisfactory repetition.

Dr. Flint has continued work on the separation of minerals from soils and their microscopic identification. The information so gained should be of the greatest aid in any systematic study of our soils.

During the year Mr. Akhurst conducted some analyses for the manganese content in rubber seeds (shells and kernels) and in a number of soil samples. No manganese was found in the soil solution, and only very small quantities in the soils themselves.

Dr. Flint pursued the development of our spectrographic technique during the year. Much time was required for working out the best details for the photographic side which is very exacting in this climate, and for fitting up extra adjustments to save time and

give reproduceable conditions. These additions have made distinct and permanent advance in the instrument ensemble. Qualitative analyses have been carried out in several instances to assist other Divisions. Quantitative work has been begun for clay analysis by means of a rotating sector giving varying exposure along the spectral lines according to a logarithmic law. The length of the lines is then an index of the quantity of the different elements present. The necessary apparatus for analysing small quantities of solution by their spark spectrum has also been made and set up.

The degree of saturation with bases is very low for Malayan soils but is still an important matter for investigation. It was desired to make a determination of this value one of the routine estimations in the laboratory. For this purpose methods of electro-dialysis were critically examined and checked with chemical displacement methods. The final form of apparatus has been settled which will enable determinations to be easily made.

Mr. Akhurst has been examining the question of the rapid fixation of phosphates in our soils, which takes place when soluble phosphatic fertilisers are applied. This has involved the special analysis of the clay fractions of the soil, and it will be necessary to examine how far the fixation removes the phosphates from availability for plant nutrition.

Minor lines of work have included dyeing of latex for safe identification of yields from experimental plots, and critical development of a special method for estimating small quantities of sodium in soil.

Meteorological.

Meteorological records have proceeded as formerly, except for the radiation records. The recorder for this purpose went out of commission early in the year. Much time was given during the year to the work of analysing and summarising the records which had already accumulated for rainfall, sunshine, soil temperature and other meteorological factors.

A former comparison over a period of six months had shown a much heavier rainfall at the Experiment Station than at the Laboratory (R.R.I. Journal, Vol. 2. No. 1). The following comparison for 1931 shows that those conditions have not held. The *distribution* of the rain during the year was excellent.

MONTHLY RAINFALL, INCHES.

	Experiment Station.	*Laboratory.*
January	11.33	9.92
February	7.63	5.92
March	6.76	7.80

April	13.10	8.34
May	4.40	2.19
June	6.75	6.85
July	5.95	6.23
August	3.16	2.50
September	10.65	10.08
October	3.79	8.96
November	12.65	13.03
December	10.96	11.76
Totals	97.13	93.58

Experiment Station.

Good progress has been made with the development of the various Blocks at the Experiment Station. Accurate data regarding growth are steadily accumulating, and are affording interesting and valuable conclusions.

Results from the Block 6 manuring experiment have already been published. One feature which has appeared from the measurements is the remarkable recovery made by numbers of trees that made little or no growth in the first year but overtook their companions later on. This response is in very marked contrast to the meagre results from the various fertilisers. In other words, some at present undefined natural improvement in environment was much more effective than well-established methods of artificial manuring. The explanation may prove to be very simple, but the observation appears to lend support to the opinion elsewhere expressed, that natural soil changes may sometimes be made to accomplish as much for a stand of rubber as the expensive ameliorations which have been developed in intensive agriculture.

Several experiments are affording information on the effects of leguminous covers on growth of young rubber. In one case, where a cover of *Centrosema pubescens* had made very vigorous growth under a fertiliser treatment, the retardation produced by it on the growth of rubber during its first eighteen months was as much as 30 per cent. In other cases of which a discussion has already been published, the effect was only 10 or 20 per cent and this is showing a strong tendency to diminish with the progress of time.

An experiment was conducted in Block 17 on the effect of surface mulching nursery plots with dry grass. It was thought that this would improve growth by keeping the soil more moist and cool in the important surface layers. The results, however, were negative.

In Block 11 periodical measurements are being made to follow the effect of belukar (secondary jungle growth) uncontrolled except

in regard to lallang. A further experiment along forestry lines has been started in Block 12 where it is proposed to bring an overgrown nursery and surrounding patches into bearing by gradual thinning and control.

Plans were completed during the year for the lay-out of an experiment on Block 19, which has budded rubber under a grass cover at present, to test the effect of regular digging. Cultivation of this sort has often been advocated, but it raises many controversial points which it is hoped that this experiment will help to settle.

During the year two virgin areas in the Forest Reserve surrounding the Experiment Station were visited and reported on in connection with the choice of land for future extensions.

A soils map of the Experiment Station was completed by Mr. C. G. Akhurst, showing the main soil types and their distribution over the various Blocks. This map with notes is published in the Journal (Vol. 3 No. 3).

Lectures etc.

Lectures were given during the year by Dr. W. B. Haines before the Kuala Lumpur Rotary Club on "A Visit to Russia," and by Dr. C. F. Flint before the local section of the Institute of Chemistry on "Spectrographic Analysis."

The Annual Conference of the Incorporated Society of Planters at Port Dickson in August was attended by the European Staff of the Division.

A contribution was prepared by the Division to the Institute's exhibit at the Malayan Agri-Horticultural Association Exhibition.

Publications.

The following articles have been published during the year by the Staff of the Division:—

1. W. B. Haines and A. S. Sanderson. "Effect of Covers and Clearing Methods on the Growth of Young Rubber" I. Journal, Vol. 3. No. 1.
2. W. B. Haines and C. F. Flint. "Manuring of Rubber—III. Resumé of Present Position Based on Malayan Data." Journal, Vol. 3. No. 2.
3. C. F. Flint. "Block 6 Manuring Experiment: Third Series of Measurements." Journal, Vol. 3. No. 2.
4. W. B. Haines. "Block 6 Manuring Experiment: Fourth Series of Measurements." Journal, Vol. 3. No. 2.
5. W. B. Haines. "Effect of Covers and Clearing Methods on Growth of Young Rubber—II" Journal, Vol. 3. No. 2.
6. W. B. Haines. "Summary of Meteorological Records, Soils Division." Bulletin No. 4.

7. W. B. Haines and C. G. Akhurst. "Soils Survey of Experiment Station." Journal, Vol. 3. No. 3.

APPENDIX.

Analysis of Correspondence.

Subject.	*Letters Received.*	*Letters Despatched.*
Cultivation	7	6
Cover Crops and Natural Covers ...	41	48
Manuring	92	106
Soil Conservation	12	15
Drainage	3	3
Replanting	21	34
Fertilisers	28	30
Soil Samples	56	72
Miscellaneous	50	101
Total ...	310	415

(Sgd.) W. B. Haines,
Head of Soil Division.

ANNUAL REPORT

BOTANICAL DIVISION.

During 1931 the Botanical Division was occupied with the same main lines of work as previously :—

1. The improvement of planting material by vegetative means, including the selection of mother trees and the development of budding technique.

2. The continuation of breeding work and seed selection.

3. The study of tapping methods on budded and seedling trees by experiment and by the collection of data from estates.

A number of smaller problems arise from these and inter-connect them so that a sharp distinction between the sections of work is not possible.

The volume of advisory work has been maintained, and, as in the previous year, certain items of the research programme of less immediate importance have had to be postponed.

For convenience of reference, as far as possible the same headings have been used as in last year's report but, where no progress is reported, experiments are merely referred to under the summary of the position at the Experiment Station. All references to block numbers apply to the Experiment Station.

PART I.

Vegetative Propagation.

1. *Selection of High Yielding Trees on Estates and the Establishment of new Clones.*

The collection of records from selected trees on estates has been continued, though, for reasons of economy and supervision, this work has had to be discontinued on a number of estates.

It is interesting to compare the records for 1930 and 1931 of certain trees already mentioned in the Annual Report for 1930 (Table 1 p. 57) for which records are available for a good many months of the second year.

TABLE I.

Yield Records of some Selected Mother Trees in 1930 and 1931.

District	Ref. No.	Ratio of Yield to Task Average		Yield of Selected Tree — lbs.	
		1930	1931	1930	1931
SELANGOR.					
Klang	B.21/44	11.0	—	81.0	101.0
Coastal ...		13.5	—	104.2	84.5
		10.3	—	63.5	72.8
Tanjong	B.21/17	9.5	8.3	73.6	73.5
Malim ...		10.2	7.1	85.9	75.4
		10.9	7.8	107.4	90.5
KEDAH					
Alor Star ...	B.21/60	13.8	5.5	92.3	36.5
		14.0	14.8	98·9	83.5
		13.5	5.8	90.1	40.5
		9.0	7.5	73.2	44.7
		10.6	8.7	97.2	45.5
		10.5	8.6	95.8	44.0

It will be seen that for most trees the ratio of yield of the selected tree to the task has fallen, though it is still well above 5, which was taken as the base level for selection. These trees were included in the previous table as they showed the highest ratios. In addition, we have records of 35 other trees for 1930 and part of 1931, and of these the ratios for 21 show a relatively small decline while 14 are equal or better. The most striking increase in ratio is from 8.0 to 15.9.

These figures may be taken as showing that, for the selection of mother trees on a ratio basis, records should be continued for longer periods. It is however reassuring to notice that very few trees have altered enough to make a difference between their selection or rejection.

The collection and multiplication of budwood from the selected trees was continued, and in December buddings from 149 selected trees were established in Block 15. Each mother tree is represented by two rows of ten buddings separated by one row of ten buddings of clone AVROS 50. The whole block is thus divided into a series of small plots of 30 trees and, as each new clone can be compared directly with the same standard clone, it will be possible to compare with a fair degree of accuracy each new clone with all the others in the block, in spite of the variations in soil and slope of land which inevitably occur in a block of over 50 acres.

A few clones of which budwood has not been obtained or is not yet multiplied have still to be included.

2. *Collection of Clones.*

In December 40 clones which have already been tapped in Malaya or in the Netherlands East Indies, but which have not yet been used on the Experiment Station, were budded in Block 15 on the same plan as for the new clones from mother trees. The collection includes older clones of historic interest and very young promising new clones. The best clones have already been utilised extensively in the larger experimental blocks.

3. *Establishment of New Clones from Seedlings.*

In October and November 583 of the 1929 crossed seedlings in Block 16 were of sufficient size for disbudding. Up to 6 buds were cut from each individual cross and budded in the field in Block 14 A and B. Every twelfth plant was budded with AVROS 50 as a standard clone.

Similar buddings made in 1930 in Block 3 have grown well, and the disbudding wounds on the seedlings healed completely in a few months. The remainder of the material from Block 4 was planted out as budded stumps in January in part of Block 25.

4. *Comparative Studies of Growth and Development of different Clones.*

(a) *Comparison under uniform conditions in the field.*

Measurements in the clone trial plot (Block 5) were continued, for the first 6 months, of height and subsequently of girth, as branching had commenced in several clones. The results are summarised in Table 2.

The heights in June 1931 place the clones in roughly the same order as in December 1930, with AVROS 49 as the tallest and AVROS 152 and Prang Besar 23 as the shortest clones. The largest actual and percentage increase was shown by clone Bodjong Datar 5.

As branching had commenced in some clones before June, height measurements alone do not give a true picture of the vigour of the clones. On girth measurements, clone AVROS 49 takes second place and clone Prang Besar 186 takes the lead, while clone Prang Besar 23 is left as definitely the smallest. The same order was maintained in December 1931, that is, when the buddings were two years old.

TABLE 2.

Summary of Growth Records of nine Clones, planted as Budded Stumps in November 1929 *on R.R.I. Experiment Station, Block 5.*

Clones	Mean Height (inches)		Mean Girth (inches)		Mean Spread (feet)
	Dec. 1930	Jun. 1931	Jun. 1931	Dec. 1931	Dec. 1931
A. AVROS 152 ...	56.0	113.1	4.0	5.6	3.2
B. AVROS 49 ...	87.6	160·9	4.5	6.4	4.0
C. Prang Besar 23 ...	61.7	110.3	3.5	5.0	3.1
D. Prang Besar 186 ...	80.9	146.3	4.7	6.65	5.1
E. Bodjong Datar 5 ...	63.3	141.8	4.1	5.6	1.8
F. Tjirandji 1 ...	72.5	136.2	4.25	5.9	4.0
G. Pilmoor A44 ...	63.7	126.8	4.3	6.0	2.5
H. Pilmoor B84 ...	86.8	145.2	4.4	6.1	5.1
J. AVROS 50 ...	71.8	143.5	4.1	5.8	2.5

The measurements given for each clone are the means of four groups of about 100 plants. As the results have not yet been analysed statistically we cannot say how far the differences in actual measurements are significant, or state definitely that one clone is more vigorous than another, but the general conclusion that, under the conditions on the R.R.I. Experiment Station, Prang Besar 186 and AVROS 49 are the most vigorous and Prang Besar 23 the least vigorous of these nine clones appears to be justified.

The mean measurements of the spread of the branches in December are less easy to classify, and are not so significant, since many trees had not started branching.

The question of the suitability of clones to special environments has been raised, and as verbal reports and opinions on the vigour of clones display striking discrepancies it was decided to undertake the collection of growth records of the more important clones from estates representing as wide a variety of conditions as possible, in

addition to the definite experiments which are in progress on the Experiment Station at Sungei Buloh.

(b) *The growth of different clones under nursery conditions.*

Measurements of the numerous clones in Block I nursery have been continued.

The study of the distinctive characters of clones in multiplication nurseries was continued and notes and sketches made, but pressure of other work prevented their duplication and issue to estates to supplement those previously issued, which have proved useful to a number of estates. Assistance has been given to several estates in the identification of wrongly labelled clones.

The latex colour test for clone identification described by Bobilioff (Archief v.d. Rubbercultuur 1931 p. 302.) has been tried on a number of clones. From the top storey a young still limp leaf is cut through the base of the stalk and the drop of latex that exudes is placed on a white tile with a drop of a one per cent. solution of calcium chloride. After a minute or two faint colours appear and gradually change until a final colour, usually purplish black, is reached. Some clones, e.g. AVROS 49 and 183 give striking colours—brick red and bright pink—others e.g. AVROS 152 and Sungei Reko 1 give very faint colours or none at all, and the majority of clones pass through faint pinks and mauves to purple and black. Further tests are necessary to arrange the well known clones in groups that can be distinguished easily, but the method has already proved useful on several occasions.

(c) *Influence of density of planting on the growth of budded trees.*

The first measurements of heights in the experiment on planting density with clone AVROS 50 in Block 14 were taken in December 1931, i.e. one year after planting as budded stumps. There is a suggestion that growth in the close planted plots is slightly superior to that in the wide planted plots.

(d) *Growth of buddings and seedlings in mixed areas.*

Block 17D is planted with alternate rows of basket plants and seedling stumps. In April the basket plants were budded with clones Tjirandji 1 and 16, Glenshiel 1, Rubana 393 and Sabrang 24, with AVROS 50 as the standard clone. Rebudding in Blocks 17A and D was completed in September. In October Block 17C was budded with the two clones AVROS 50 and Pilmoor D65. The relative growth and methods of control of the development of buddings and seedlings will be studied in these areas.

5. *Experiment on Estates.*

(a) The experiments on Changkat Kinding Estate, Gunong Kroh Estate, and Lubok Segintah Estate mentioned in the Report for 1930 have been continued. Measurements were made in August, but no results of special interest have so far been obtained.

(b) The growth on the replanted area on Edinburgh Estate is rather uneven and at the top of the slopes is disappointing, but it is hoped that the growth will improve during the next year. Height measurements were postponed until after the end of the year.

(c) Old rubber areas have also been replanted and budded on Sungei Tankas Estate, Kajang on fairly typical laterite soils. The manager has very kindly offered us areas for observations, and two areas planted with several clones have been selected for future records: one is on a gentle slope and the other includes steep slopes and almost bare laterite hill tops.

6. *The Mutual Relationship between Stock and Scion.*

(a) *Laboratory Investigations.*

The investigation mentioned in the Annual Report for 1930, of the latex vessel systems of the Pilmoor clones has been extended by Mr. K. N. Kaimal to the other 15 less promising clones, but the detailed examination of the numerous bark samples has not been completed. It is hoped later to discuss the results in a separate paper.

(b) *Field Studies.*

(i) The stocking of the nurseries in Block 25 for later budding work has been continued, and seedlings from most of the well known Malayan and AVROS clones as well as a further supply of twin seedlings of the Pilmoor clones A44 and B50, have been planted.

(ii) Two areas of about 5 acres isolated in the jungle have been partly cleared and have been planted with stumps for later budding with *Hevea spruceana*, alone in one area and mixed with certain clones of *Hevea brasiliensis* in the other.

(iii) An experiment to study the yields of buddings and of their stocks when budded at different heights was planned by Mr. Mann and started in October in Block 10 (10 acres). The plants were 2 years and 9 months old at the time of budding and their mean girth at the collar was 12.5 inches with a range from 9 to 19 inches. The block was divided into five sections of five rows of 30 trees, separated by single rows of seedlings. Each section was budded with one clone in rows at ground level and at heights of

one, two, three, and four feet. The clones used were Bodjong Datar 5, AVROS 50 and 152, Sungei Reko 9 and Prang Besar 186. When the budded trees were cut back the control rows of seedlings were also pollarded at four feet.

This experiment has also been utilised for the study of variations in the procedure of budding big stocks (see section 7 below.)

(iv) The effect of the vigour of the stock on the vigour of the bud shoot has been studied in Block 3.

The girths of the seedlings were measured at the time of budding in December 1930. Up to six buds from each of about 150 clones derived from the crossed seedlings in Block 4 were used. Clone AVROS 50 is also included, and thus the contents of the block are well mixed.

The heights of the bud shoots were measured in July and again in December. Grouping of the stocks in order of girth and calculation of the mean height of the bud shoots on each group show that there is a marked increase of height of the bud shoots with increase in size of the stocks up to about 12 cms. girth. The difference is even more marked at one year than at 7 months and so is likely to persist for some time longer (vide Table 3).

As the budding was carried out in the field on stocks of equal age it is obvious that careful selection of stocks is necessary in order to establish an even stand of buddings. It is suggested that at least three seedlings, and preferably more, should be planted in each hole and the most vigorous budded, in order to achieve eventual uniformity.

This result had already been suggested by other experiments.

The range of the girth of the stocks at the collar was roughly from 5 to 15 cms. (2 to 6 inches). Further data will be obtained from Block 21 with a wider range of stocks up to over 25 cms. in girth.

7. *Budding Procedure and After Treatment.*

During the year there has been an increased interest in the budding of large stocks of three and more years of age. Unfortunately we had no material of this size available for experiment and much advisory work had to be based on experience of estates and on general principles.

In October when the $2\frac{3}{4}$ years old plants in Block 10 were budded the opportunity was taken to clear up a few points that had been suggested during the year. The experiment is still in progress but a few preliminary results may be mentioned below as indicating lines for the modification of present practice. When complete the results will be published separately.

TABLE 3.

Data illustrating the influence of stock vigour on scion growth.

Block 3—Budded in the field in December 1930.

Mean Girth of Stock (cms.)		5	6	7	8	9	10	11	12	13	14	15
Mean Height of Bud Shoot (cms.)	July 1931	98	111	125	143	157	170	178	173	186	192	191
,, ,,	Dec. 1931	136	150	165	192	203	216	242	219	249	252	252
No. of plants in December 1931 ...		22	76	129	99	74	50	44	45	47	29	31

(a) Green versus brown budwood. Each of the five clone sections was divided into three and budded with green, intermediate, and mature brown budwood, all of which was freshly cut from the nurseries. The results at the time of opening and cutting back show that, although the success with green wood is definitely lower than with brown wood, it is still quite good, and where supplies of budwood are limited the use of green wood is quite practicable.

(b) Time of Opening. The time of opening the bandages after budding was varied. There was little difference between the percentage of buds alive at opening after 18, 23 and 28 days, but the losses between opening and cutting back 10 days later were less with the longest period before opening.

(c) Time of cutting back. In Block 21 the largest 270 plants were used to examine the influence of the period elapsing between opening of the bandage and cutting back. There was no apparent difference between 7, 14 and 21 days. The time of opening was constant at 20 or 21 days after budding.

(d) Snag treatment. An article on "The Protection of Pruned Surfaces in Budding Operations" by Mr. Sharples (Head of the Pathology Division) and Mr. Mann was published in the Institute Journal, Volume 3, No. 1. Since then it has appeared that it may be advisable to make the final pruning without waiting for the formation of two feet of brown wood at the base of the bud shoot.

Experiments made by Mr. D. S. Thomson on Carey Island have shown that more rapid healing over is obtained on large stocks (4 to 8 inches diameter) by making the final pruning when the bud shoot is showing only about six inches of brown wood. The slope of the cut should follow the ridge on the growing stock below the dead snag, and end just below the edge of the flange of callus at the origin of the bud shoot. Observations on other estates have tended to confirm these general principles and experiments on Block 10 are being continued to throw light on the problems of the pruning and healing of snags on big stocks.

(e) Forcing out the bud. After budding, especially on large stocks, some clones are rather slow in shooting. The previous recommendation to cut a notch about $\frac{1}{4}$ inch deep and $\frac{1}{2}$ inch above the bud has again proved useful in forcing out dormant buds.

(f) Lateral roots of budded stumps. In an article on "The Development of Young Hevea Buddings" (De Bergcultures 5th year, No. 28 : 11th July 1931 : p. 675 "De Ontwikkeling van jonge Hevea Oculaties") Ostendorf gives the results of an experiment with clones AVROS 50 and Cultuurtuin 88. Stocks were budded and one third left in situ, one third removed immediately after cut-

ing back and replanted with as many roots as possible, and the remainder replanted after removal of lateral roots. Shooting of the buds was quickest for the undisturbed plants (i.e. budded in the field) and slowest for the stumps transplanted without side roots. For both clones the time taken for 50 per cent of the buds to shoot was about 10 to 14 days less for the stumps with roots than for those without.

This may be of great importance if budded stumps are transplanted just before a period of dry weather. Unfortunately neither time nor material was available for a large scale experiment, but a preliminary trial was made in October with 50 to 100 budded stumps of clones AVROS 50, Pilmoor A44 and B84, which were put out as controls with the crossed seedlings in Blocks 14E and 25. The stumps were divided into three groups in which the lateral roots were cut off completely or pruned back to 6 and 12 inches from the tap root.

Observations on the lengths of the bud shoots were still being continued at the end of the year, but over 90 per cent of the stumps had shot and all clones showed a definite advantage for the stumps with side roots over those without. The previous recommendation to leave several inches of the main lateral roots when transplanting budded stumps is confirmed by this experiment and appears to be worthy of emphasis.

PART II.

Breeding, Seed Selection and Seedling Growth.

1. *Establishment of Seedling Families from High Yielding Trees on Estates.*

As mentioned in the last report it was hoped to establish seedling families from the estate mother trees selected for the development of new clones. In 1931 seed was again scarce and germination of some families very poor. Seeds were obtained from a furthur 19 trees on 8 estates. In December 1931 the seedlings were planted as basket plants together with the 1930 seedlings as stumps in Block 25. With a few groups still to be shifted there is a total of only 34 tree families from 15 estates. Seed was also obtained from a number of well known clones—Glenshiel, Prang Besar, Sabrang—and groups of seedlings from these were planted as basket plants in Block 25. Seed from several AVROS clones and also from an isolated garden containing only Rubana clones 424 and 426 was received too late for the seedlings to be transplanted in 1931.

2. *Hand Pollination.*

In the first flowering season further crosses were made between the clones on Pilmoor Estate, and all combinations between the six highest yielding clones were completed.

The second flowering season was very poor, and work was also held up by the pressure of advisory work on budding. Crosses were however made between three of the best Pilmoor clones and clone Glenshiel 1. Twigs of the latter with male flowers were taken from the young trees on the Cheras Division of Glenshiel Estate and used for pollination on Pilmoor Estate on the same day. At the end of the year the fruit from these crosses though full sized were not ripe and the final figures may need correction.

In the first season clone Pilmoor D61 gave a heavy first set of fruit but shedding was severe, and a number of the first picked seeds were partially empty and non-viable. Clone B16 gave particularly poor results. Only 1 fruit was obtained from 600 pollinations. The results are given in Table 4.

TABLE 4.

Seasons	Flowers	1st set of Fruit (per cent)	Fruits	Success (per cent)
First Crosses ..	2,411	14	120	5.0
Selfs ...	79		0	0.0
Second Crosses ..	152	30	35	23.0
Total ...	2,642	—	155	5.9

In addition, Asiatic Assistants made a further 1,038 pollinations under supervision and obtained 30 fruits.

The fruits from the 1930 second season were picked when ripe, and the seedlings were planted in Block 25. The seedlings from the 1931 first season pollinations have been planted in Block 14E.

Records of temperature were taken on the days when pollination was carried out. Analysis of the records for 1929 and 1930 shows no apparent influence of temperature on the success of pollination.

A few more experiments in pollen germination were made.

3. *Seedling Growth.*

Measurements of height and girth have been made periodically in all blocks to establish records of the early history of the pedigree seedlings, and to obtain information as far as possible on various aspects of seedling growth.

Block 2. In February and December, measurements were made of the total length of branches of the seedlings and these were compared with the girth records. When the trees are grouped by their girth, the mean length of branches of each group is constant up to a girth of 11 cms. in February and 10-15 cms. in December, and then increases rapidly with increasing girth. There are still a number of trees which have not started branching and the frequency distribution for branch length is extremely asymmetrical.

Certain families stand out for their prolific branching and large girth, and suggest that vigour of growth is determined by hereditary as well as environmental influences. In many families also striking similarities of branch form are apparent between sister seedlings.

In this block girth measurements were first taken at the end of April 1930 and have been repeated at 3 monthly intervals. The mean girths at a height of 50 centimetres (20 inches) are shown below (Table 5) for over 900 trees, which were planted as basket plants or stumps in October and November 1928. They are some of the oldest plants on the Experiment Station and show that the average growth is quite good in spite of the first two very dry years 1929 and 1930.

TABLE 5.

Block 2. Growth Records: Girth in cms.

Approximate Date	27.5.30	27.8.30	2.12.30	3.3.31.	3.6.31	3.9.31	8.12.31
Mean Girth ...	11.7	13.7	15.8	18.8	23.0	25.3	28.3

PART III.

Tapping Experiments.

1. Tapping of Budded Trees.

(a) *Pilmoor Estate* :

The tapping experiments on the clones established on Pilmoor Estate in November—December1924, described in the Annual Reports for 1929 and 1930, have been continued. Mr. F. Billington left on long leave in February and Mr. K. N. Kaimal continued the supervision of the experiment.

The trees were tapped on the same panel throughout the year, and were not rested during wintering as in previous years.

In June individual tree records were stopped, and instead of coagulating the latex in the cups and collecting the biscuits a simpler and more economical method was adopted. The latex from all the trees in a clone on one system of tapping was bulked and taken to the factory for coagulation in pans and manufacture into smoked sheets. Lumps from sieving and tree scrap were crêped and weighed separately. The method of collection therefore is now exactly comparable with the method employed in ordinary estate practice.

The records for the six clones are summarised in Table 6.

Bark consumption from May 1930 to April 1931 on the trees tapped alternate daily ranged from 0.64 inches per month in clones B84 and B16 to 0.71 inches per month in clone A44.

In group B bark consumption was lowest (1.18 inches per month) in clone D61 and highest (1.28 inches per month) in clone A44.

Of the 27 trees recorded as having suffered from brown bast 7 recovered completely and were included in the 1931 tapping test.

All clones have increased in yield. Clone D65 is very promising for a young clone and its yield is equal to the previous best record of a Malayan clone of 6—7 years old.

Clone B84 again gave a considerably higher yield on the daily alternate monthly than on the alternate daily system of tapping.

Wintering was very severe in clones B58 and B84, which shed all their leaves and showed a considerable drop in yield in March and April. Clone D61 lost the leaves of the lower branches only and in clone B16 leaf fall was slight. Clone D65 lost no leaves and its yield did not decrease. Wintering in clone A44 was prolonged. The lower branches lost their leaves and began to shoot again before leaves fell from the top branches and the low yields persisted from February till June.

TABLE 6.

Yields and Girth of the Pilmoor Clones 1931.

Clone.	Group A Tapped Alternate Daily - 178 days					Group B Tapped Daily in Alternate Months – 179 days					Group A	Group B
	No. of Trees	No. of Trees with Brown Bast	Mean Girth at 1 metre (cms.)	Mean Yield		No. of Trees	No. of Trees with Brown Bast	Mean Girth at 1 metre (cms.)	Mean Yield		Mean Yield for 1930 (9 months) grams per tapping.	
				Per Tapping (grams)	Per Tree per 160 Tappings (lbs.)				Per Tapping (grams)	Per Tree per 160 Tappings (lbs.)		
A 44	48	4	58.4	20.2	7.1	49	4	58.4	22.8	8.0	18.7	18.7
B 58	32	1	55.9	24.7	8.7	34	2	54.6	25.4	9.0	20.3	19.4
B 84	17	2	68.6	26.2	9.2	17	2	67.3	32.1	11.3	20.1	23.0
D 61	14	2	55.9	23.3	8.2	10	2	57.2	25.0	8.8	18.0	17.5
B 16	35	5	61.6	32.4	11.4	34	3	61.6	33.5	11.8	24.7	23.0
D 65	4	...	76.2	45.2	15.9	...	...	...	...	...	31.1	...

In November five trees of each of the other 15 clones, which had previously given poor yields and had been rested since February 1930, were tapped again. One or two clones showed a favourable increase in yield and will be tapped again in 1932.

The budded area was originally square-planted at 20 × 20 feet. A number of spaces due to failures of buddings, and the roads at the sides of the block give some trees more than their allotted space, and in addition thinning was carried out in May 1930. Trees were grouped according to the number of their immediate neighbours and their yields for 1929-30 and their girth in 1929, 1930 and 1931 were compared, but there was no apparent increase in girth or yield with increased spacing.

(b) *Glenshiel Estate* :

During 1931 we continued to receive the records of clone Glenshiel 1 tapped on several different systems. In addition to the trees previously tapped two groups of young trees, four years old at the beginning of the year were brought into tapping. Unfortunately, for the convenience of the estate supervision the tapping systems of groups II and IIC, were changed in the second half year.

Several trees have shown a curious tendency for their yields to drop for several months after which the yield increases to normal. These trees have all been kept in the tapping tests and their low yields are included in the means shown in Table 7.

Yield records of two younger clones, Glenshiel 11 and 13, were commenced when they were 6 years and 4 months old. Two groups in each clone are tapped alternate daily and one group is tapped daily in alternate fortnights. We wish to express our thanks to Mr. J. H. H. Bailie and to Mr. W. A. D. Wynch for continuing these experiments and records.

2. *Test Tapping Young Seedling Trees.*

(a) *2¾ Year Old Trees on the Experiment Station.*

In view of a number of enquiries on the methods of test tapping seedling trees before thinning out, and the probable future importance of the problem in connection with areas densely planted with selected clone seed a preliminary experiment was started in Block 4C. About 150 trees were planted in 1928 to compare the growth of seed at stake and germinated seed. Seventy trees with a girth of thirteen inches or over at a height of ten inches from the ground were selected, and opened with a single cut at a slope of

TABLE 7.

Summary of the results of tapping experiments on clone Glenshiel 1 from January to December 1931.

Group No. of Trees	System of Tapping	Average girth at height of 40" from union cms.	inches	Yield in grammes per tree per tapping. Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean per tree in grms. per tapping	Yield expressed as % of Group 1 Control=100
I. 20	Tapped alt. daily on ½ cut	86.4	34.0	63.5	59.4	52.5	51.7	65.9	68.1	67.3	65.5	63.8	66.1	68.6	69.5	63.5	100
IA. 20	Alt. daily on ½ cut on days when I is resting	82.6	32.5	72.8	65.7	64.7	64.2	68.7	70.6	65.7	60.1	63.9	62.8	64.0	64.8	65.7	103
II. 20	Daily alt. monthly on ½ cut	83.8	33.0	..	74.3	...	60.9	...	57.9	...	...	..	...	...	..	64.4	101
III. 20	Daily alt. fortnightly	85.1	33.5	69.7	61.2	66.5	60.5	65.0	69.2	72.7	65.0	69.6	65.7	67.9	69.0	66.8	105
IV. 20	Heusser system 2 cuts ¼ alt. daily	83.8	33.0	71.6	68.2	64.2	64.8	66.6	71.7	73.5	68.2	72.0	69.5	75.4	74.6	70.0	110
V. 20	Alternate daily on 1/3 cut	83.8	33.0	62.0	58.4	56.5	50.0	58.3	63.6	65.1	60.1	62.1	61.3	64.0	68.3	60.8	96
VI. 20	Daily alt. fortnightly on 1/3rd	84.5	33.25	51.8	47.8	53.5	43.6	49.9	52.6	59.4	53.3	55.4	54.1	54.4	59.7	52.8	83
IC. 10	Alternate daily on ½ cut	..	..	14.7	13.9	9.5	13.2	14.6	18.1	20.1	13.9	13.2	16.0	18.1	18.0	15.3	...
IIC. 10	Daily alt. monthly on ½ cut	...	...	11.3	...	11.5	...	12.6	...	12.3	...	...	...	...	..	11.9	...
IIIC. 10	Daily alt. fortnightly on ½ cut	..	...	...	...	...	...	...	..	...	...	16.2	16.1	15.3	14.1	15.4	...

Age of trees in December 1931 — Groups I to VI. 10 years.
— „ Ic, IIc and IIIc. 5 years.

30 on half the circumference at a height of ten inches. Tapping was continued daily for a month. The latex was coagulated in the cup, the small biscuit so obtained pressed together with the cut scrap and hung on a labelled wire on the tree. Each day's biscuit was separated from the next by a dated label.

The chief objects of the experiment were to establish correlations between yield and vegetative characters, and to see whether periods of tapping shorter than one month would suffice for the selection of the lowest yielding trees.

The examination of the data had not been completed by the end of the year but it has appeared that there is a high correlation between the yields of individual trees for periods of 5 and 7 days and the yields of the whole month.

The following correlation coefficients between vegetative characters and yield were calculated.

Yield and girth at 10 inches	...	r	=	0.603	± 0.051
Yield and numbers of latex vessel rows at 10 inches	...	r	=	0.205	± 0.077
Yield and bark thickness at 10 inches	...	r	=	0.111	± 0.08

The correlation between yield and girth is unusually high. This is probably due to the selection of only the trees with the greatest girth, but it is not sufficient to justify thinning out on girth alone.

A larger scale test has been planned for Block 2.

(b) *Five year Trees on Dindings Estate.*

We are indebted to the Acting Manager of Dindings Coconut Estate, Bruas for sending us daily tapping samples from a group of 100 five year old trees which were test tapped in November.

Correlation coefficients have been calculated between the month's yield and girth and bark thickness.

Yield and girth	...	r	=	0.444	± 0.054
Yield and bark thickness	...	r	=	0.225	± 0.064

The uselessness of these characters as a basis for thinning out can be still further emphasised. The trees were arranged in order and the 25 trees of lowest girth included only 10 of the 25 lowest yielding trees, while the 25 trees with thinnest bark included only 4 of the 25 lowest yielding trees!

A second group of 100 trees is being tapped and it is proposed to publish separately a detailed analysis of the results of these experiments.

(c) *Nursery Seedlings.*

After preliminary trials with Dr. Cramer's patent test tapping knife, which imprints four small V cuts in the bark, on buddings of various clones a larger trial was made with one year old seedlings of the Pilmoor clones A44, B50 and B58 and mixed seedlings from the Malayan American Plantation clones. They were divided into three groups according to the amount of latex flow, and representatives of each group were planted as stumps in the western 10 acres of Block 14E. Figures of the flow recorded for individual seedlings have been kept for future reference and comparison.

The only published results of tests with this knife are for small groups of seedlings, and it is desired to emphasise the fact that this planting is purely experimental. Variable factors such as weather conditions and viscosity of latex exercise a considerable influence on the abundance of latex flow and may affect the reliability of this method of selection—quite apart from probable changes with age before the seedlings are old enough to be tapped.

PART IV.

Cover Plants.

The demonstration plots in Block 13B have been rearranged in systematic botanical order round two sides of the Block. The centre is left for experiments.

The herbarium collection of plants used as cover crops or found growing on the Experiment Station and estates has been extended, and now includes 187 species—(a) cover crops—41, (b) other flowering plants—128, (c) ferns and their allies—18. Of the species in groups (b) and (c) 93 were collected from the Experiment Station.

PART V.

Experiment Station.

Although most of the experiments in progress or started during the year have been referred to previously, it is convenient to summarise the position on the individual Blocks.

Block 2: Measurements of the girth of the seedlings were taken every three months. The length of branches was estimated in February and December.

Block 3: The buddings from the crossed seedlings in Block 4 have been measured twice. Growth is definitely least on the smallest stocks.

Block 4A: Girth measurements continued every two months.

Block 4B: Multiplication Nursery. Measurements were repeated. New clones from estate selected mother trees were multiplied and used in Block 15. Budwood of a number of clones was cut for budding other blocks.

Block 4C : Growth measurements of the twin seedlings were continued.

The largest ordinary seedlings were used for an experiment in test tapping in August when they were $2\frac{3}{4}$ years old.

Block 5: Height measurements of the nine clones were continued till June, and measurements of girth and spread were started.

Block 10: The seedlings in this block were budded in October with clones Bodjong Datar 5, AVROS 50 and 152, Prang Besar 186 and Sungei Reko 9 at heights of 0, 1, 2, 3 and 4 feet.

The effects on the final success of different times of opening the bandage, and different states of maturity of the budwood were compared.

Block 13A: The cover crop demonstration plots have been reorganised and mostly replanted. Rubber seedlings have been planted as basket plants.

Block 14: Section B and part of Section A have been budded with 583 groups of buds cut from seedlings in Block 16 derived from the 1929 pollinations on the Pilmoor clones, and with clone AVROS 50 as a control.

In sections C. and D the buddings of clone AVROS 50 at different densities of planting have been measured.

Section E1 has been replanted with stumps from clone seedlings selected by Cramer's knife test in Block 25 nursery.

Section E2 has been replanted with the 1931 Pilmoor crossed seedlings as basket plants. The surviving original seedlings, planted at 30 × 30 feet, have been budded with Pilmoor clones and clone AVROS 50 and transplanted between the groups of crosses in Blocks 14E and 25 to facilitate comparison of the characters of the seedlings and eventual back-crossing with their parents. These budded stumps were also utilised for an experiment on the influence of the length of lateral roots on the shooting of the buds.

Block 15: Was divided into plots of 30 trees. In 149 plots two rows of 10 plants were budded from estate selected mother trees, and 40 plots were budded from tested estate clones. Each plot was budded with a central row of clone AVROS 50 at the same time as the side rows.

Block 16: Measurements were continued at two monthly intervals.

Block 17: Sections D and C were budded in April and October with clones Tjirandji 1 and 16, Glenshiel 1, Rubana 393, Sabrang 24 and AVROS 50, and with Pilmoor D65 and AVROS 50 respectively. Supply budding in section A was completed.

Block 18: Supply plants were put out.

Block 19: Budding with clone Bodjong Datar 5, started in 1930, was completed.

Block 20: Originally planted at 30 × 30 feet, most of this block has been interplanted with basket plants at 15 × 15 feet to give a sufficient stand for experiments on the duoclone budding system.

The unsuccessful cover crop plots and most of the clean weeded plots have been planted with cover plants.

Block 21: The girths of the seedlings were measured, and the block was budded in October with clones Tjirandji 16, Bodjong Datar 10, Cultuurtuin 88, AVROS 50, 71 and 256 and Sungei Reko 9.

The clean weeded strips were planted with covers and the unsuccessful covers replaced.

Block 22 (part): More plants of *Castilloa elastica* were put out in the collection of non-Hevea rubber plants, which now includes *Manihot glaziovii, Castilloa elastica, Sapium acuparium, Dyera laxiflora, Mascarenhasia elastica* and *Palaquium* species (Taban and Nyatoh).

Block 24: Budding with clone Bodjong Datar 5, started in 1930, was completed.

Block *25:* The surplus of the buddings from the crosses in Block 4A, which could not be included in Block, 3 were planted as budded stumps in January.

The seedlings from the 1930 second season pollinations were transplanted as basket plants.

Budded stumps of the parent clones were planted between the groups of seedlings in October.

Stumps of twin seedlings were planted with control stumps in the odd corner of just over one acre in the north west of the block.

In December the sections of this block, east of the Sungei Payong, were planted with basket plants and stumps of the 1930 and 1931 seedling families of selected mother trees and well known clones.

Planting of the nursery with seeds from a number of clones for future budding work was completed.

Advisory Work.

Correspondence and Visits.

Most of the advisory work—correspondence, visits to estates and interviews at the Institute have been in connection with budding. The next most prominent subject has been tapping of buddings and seedlings, while the large number of letters dealing with the selection of mother trees is in connection with the establishment of new clones on the Experiment Station.

An analysis of correspondence received and despatched appears as an appendix, but it is interesting to examine it further. Of 505 letters written to Estates or Agencies and individuals on Budding, 125 dealt with information concerning clones and the choice of clones for planting, 45 dealt with budding on old stocks or high budding, 35 concerned the identification of clones in multiplication nurseries or as budwood, 22 on pruning and the treatment of snags, and 278 covered numerous smaller problems generally connected with budding as well as those just mentioned.

During the year the same clones were recommended as in 1930. A number of enquiries have been concerned with rumours of the failure or unsuitability of various clones. Most of these were baseless and have involved considerable correspondence with the Proefstations in Java and Sumatra and with estates.

The files relating to the test tapping of buddings now cover 25 estates: 90 letters were written and, in addition to Pilmoor Estate and Glenshiel Estate, 9 estates were visited for advice on test tapping and the identification of estate clones.

Many of the enquiries on tapping mature seedling rubber have again been in connection with A.B.C. systems and resting periods. Attempts to start experiments have not been successful owing to the present conditions of reduced expenditure and diminished supervision on estates.

Six estates completed the experiments on the effect of stopping tapping on Sundays, which was referred to in the report of the Director for 1930. On one estate the experiment was delayed by an A. B. C. rest and the last tapping was not completed until December. Since then the results have been analysed for publication.

There have also been a number of letters dealing with the test tapping of seedling trees preparatory to thinning out.

During the year 99 visitors came to the Division and a number were also taken over the Experiment Station.

Publications and Lectures.

The following articles were published in the Journal of the Institute by Mr. C. E. T. Mann: "Further Observations on Planting Systems for Budding of Tested Clones" Vol. 3: No. 1: and in conjunction with Mr. A. Sharples "Standard Instructions for the Protection of Pruned Surfaces in Budding Operations": Vol. 3: No. 1:

Lectures were given by Mr. C. E. T. Mann on "Recent Advances in Budding of Hevea" to the Negri Sembilan Planters' Association at Seremban on March 28th; and by Mr. L. E. Morris on "The Present Position of Selection of Hevea" to the Muar District Planters' Association on March 1st, and on "Budding and Variation" to a gathering of managers of estates in Messrs. Sime, Darby's Agency, at Merlimau Estate, Malacca on December 12th.

Exhibitions.

At the Malayan Exhibition held by the Malayan Agri-Horticultural Association in Kuala Lumpur from August 1st to 3rd an exhibit was arranged to illustrate budding work and the principles of the identification of clones. Demonstrations of budding were given by Malay, Indian and Chinese budders and conductors.

General.

Mr. C. C. T. Sharp joined the Division on February 26th and has been occupied mainly with work on budding.

Mr. F. Billington (Field Officer) who had been attached to the Division went on long leave in February.

Mr. C. E. T. Mann (Plant Physiologist) left on Home leave on June 18th and was absent for the rest of the year. Mr. L. E. Morris (Geneticist) assumed duties as Acting Head of the Division.

Unfortunately, during an extensive tour of estates in Perak and Kedah, Mr. Sharp became seriously ill and was absent from duty for six weeks. Happily, he made a rapid recovery and we were able to complete the budding and planting programme on the Experiment Station.

It is a pleasure to record our great appreciation of the assistance given by the Manager and Assistant Manager of the Experiment Station in carrying out and controlling field work.

Our thanks are also due to the Managers and Assistants on all the estates on which experiments have been carried out, to those who have sent us records, and to the members of the junior staff for the diligence and interest with which they have carried out their duties.

(Sgd.) L. E. Morris,

Acting Head of Botanical Division.

APPENDIX.

Analysis of Correspondence.

Subjects	Letters received.	Letters sent out.
Budding—General ...	543	564
„ —Training of Conductors and Pupils from Estates, etc. ...	6	8
„ —Field Trial Experiments (Estate Trials) ...	6	7
Budwood—Purchases and Exchanges ...	11	18
„ —Packing and Treatment ...	4	4
Budding—Special Materials ...	14	13
Tapping—Estate Enquiries (General) ...	68	76
„ —Estate Enquiries (Tapping of Budded Trees)	1	2
„ —Estate Experiments (General)	—	5
„ —Estate Experiments (Tapping of Budded Trees)	75	84
Test Tapping of Seedlings ...	10	12
Tapping—Tapping Systems (Sunday Tapping) ...	36	39
Stock Experiments on *Hevea Spruceana*	1	2
Tapping—(Untensils) ...	2	3
Selection—Individual Mother Trees ...	193	215
Estate Yields ...	1	1
Seed Selection ...	46	43
Isolation Gardens ...	11	15
Pollination ...	2	2
Seeds—Germination ...	2	2
Seeds for R.R.I. Experimental Purposes	15	4
Requests for Seed ...	5	1
Seed—Identification, etc. ...	2	1
Non-Hevea Plant—Rubber Producing Plants other than Hevea ...	1	2
Cover Plants ...	25	23
Catch Crops ...	4	5
General Physiology ...	16	24
Apparatus ...	1	2
General Planting Enquiries ...	7	8
Total ...	1,108	1,185

ANNUAL REPORT

PATHOLOGICAL DIVISION.

Staff.

Approval having been given by Government for my secondment from the post of Government Mycologist, Department of Agriculture, S.S. & F.M.S. to that of Head of the Pathological Division of the Institute I assumed duties on my return from leave on the 5th February 1931.

Various staff changes were made soon after my arrival. A vacancy on the staff arose through the unfortunate demise of Mr. H. Sutcliffe in 1930 while a second vacancy was occasioned by the retirement of Mr. A. R. Sanderson on the 11th of April, 1931. Both these officers had long experience in rubber tree pathology and their absence has resulted in a very definite increase of work and responsibility on the divisional staff. The extra burden was relieved by the transfer of Mr. F. Beeley, Field Officer attached to the Division, to the post of Pathologist on the scientific staff, as from April 1931. Unfortunately a serious illness overtook this officer soon afterwards and he proceeded on leave on medical advice on 14th August 1931. The divisional staff was further increased by the attachment thereto of Dr. A. S. Corbet, Bacteriologist, who formerly worked in the Soils Division and Mr. H. Gunnery, Technician, who was formerly attached to the Botanical Division. Dr. Corbet proceeded on leave on 3rd May 1931, so that the staff, for a large portion of the year, has consisted of the Head of the Division with one pathologist Mr. R. P. N. Napper, and Mr. Gunnery. I wish to place on record my appreciation of the strenuous work carried out by these two officers. As a result, the research work has progressed at a much more rapid pace than could have been contemplated at the beginning of the year. I am also pleased to record the excellent work done by the Asiatic staff.

Experimental Blocks at the Experiment Station, Sungei Buloh.

The first matter of importance to be considered was the experimental blocks under the control of the Head of the Pathological Division at the Experimental Station, Sungei Buloh. A lengthy report was submitted suggesting a redistribution of blocks so that a number, not required by the Pathological Division, could be placed under the charge of other divisional heads. The main items in the report were agreed to and the present position is that the Pathological Division takes direct charge of certain blocks of definite pathological significance, and supervises the general disease work over the re-

mainder of the Station. This arrangement has resulted in a reduction of the acreage of experimental blocks under the charge of this division from 275 acres to 61 acres.

Main Lines of Research.

This report may be conveniently read in conjunction with the programme of research which I submitted in the early part of the year. In this programme I suggested a main line of research for each officer in the division.

Root disease caused by *Ganoderma pseudoferreum. Wakef.*

Investigations into the damage caused by root disease in old rubber areas had been carried on by Mr. A. R. Sanderson for some years and two comprehensive reports were available as a result of the work. This work was continued by the writer, and further important observations were made during the year. The nature of these observations led to the publication of a comprehensive bulletin (No. 3) which has aroused much interest among the planting community. As the publication is of recent date there is no necessity to expound the more important findings in this report. Owing to shortage of staff a halt has had to be called in these investigations but it is hoped to continue them in 1932.

Root disease caused by *Fomes lignosus.*

The investigation of this disease by Mr. R. P. N. Napper has yielded many unexpected results. The more important points suitable for an annual report are given below, but a fuller report is available and will be published later. The results of the investigations which have so far been obtained are remarkable in that they are entirely at variance with the ideas which held sway when the experiments were laid down. It is not known for certain what were the expectations of the results of the experiments but it is probable that they have been completely reversed in the outcome. There is not the slightest doubt in the writer's mind as to the necessity for repeating the experiments on a larger scale and, if confirmation can be obtained, it will be necessary to change the present conceptions of dealing with plantations during the first six years of development. The legitimate deductions to be made from these experiments at the present date are :—

(a) Up to an age of three years, rubber trees are exposed to a greater risk of infection from *Fomes lignosus* in an area from which surface timber and jungle stumps have been removed than in an uncleared area.

(b) It is probable that the incidence of the disease in a young clearing is less under a cover crop than in clean weeded areas.

(c) Up to the age of three years the incidence of the disease on rubber trees is probably least where secondary jungle has been allowed to grow up, as a natural cover.

(d) Applications of lime encourages the growth of the fungus.

(e) An aqueous solution of copper sulphate at a 2 per cent strength is able to kill superficial mycelium upon the roots of rubber trees if it comes into direct contact with the mycelium.

(f) It has been found that fructifications of *F. lignosus* spore freely at certain seasons which probably occur after periods of heavy and continuous rain.

(g) The mycelia isolated in pure culture from (i) the fructifications (ii) the rhizomorphs (iii) from diseased wood are identical in macroscopical vegetative characters, but that from spore cultures, has a slower growth rate and produces more aerial mycelium on nutritive media.

(h) Rhizomorphs and fructifications can be obtained under experimental conditions in the laboratory from naturally infected material. The most profuse rhizomorph formation takes place in the absence of light; when exposed to light there is a tendency to form fructifications. Fructifications developed in the laboratory can produce spores even in the very early stages of development.

(i) Typical rhizomorphs, as found in the field, develop freely in root disease investigation boxes under experimental conditions.

Leaf diseases.

Our knowledge of the leaf diseases of the rubber tree is very fragmentary, and to repair the deficiency, this line of work was taken up by Mr. F. Beeley. The work came to a stand-still when this officer was taken ill and cannot be recommenced until his return from leave.

Sulphur dusting experiment against *Oidium Heveae*.

Plans for large scale Sulphur dusting experiments against *Oidium* leaf disease were drawn up and preliminary work was successfully undertaken. The failure of any *Oidium* attack to develop in 1931, negatived our efforts in this direction. It seems clear that the damage done by this disease in Malaya depends entirely on climatic factors, the most important of which, for successful development,

appears to be an abnormally long dry spell following the normal wintering season.

Morphological work on various pathological subjects.

Work on these lines has been carried out by Mr. H. Gunnery. In addition to the important work on callus formation which will be published as soon as possible, new ground has been broken by investigations on diseased root tissues attacked by *Ganoderma pseudoferreum* Wakef. and *Sphaerostilbe repens.* B & Br.

Further Research Items.

The main lines of research are referred to above. The following list gives the varied subjects which have come under review during the year :—

(a) Lightning injury on Rubber plantations.
(b) Bud-grafting on old stocks and protection of pruned surfaces with Asphaltum-Kerosene mixtures.
(c) Host-parasite anatomical relationships in *Ganoderma pseudoferreum* Wakef. and *Sphaerostilbe repens* B & Br.
(d) Studies on *Sphaeronema fimbriatum,* the cause of Mouldy Rot disease, and experiments on control with proprietary disinfectants.
(e) Internal Bark fissures.
(f) Bark bursting by formation of rubber pads between bark and wood.
(g) Cockchafer grub plague.
(h) Various insects pests.
    (i) Grasshoppers
    (ii) *Orygia turbata*
    (iii) White Ants
    (iv) Mites.
(i) Damage by Squirrels.

Lightning Injury on Rubber plantations.

Lightning in relation to diseases of rubber trees has been previously considered of relative unimportance. As a result of many years work the writer has proved that lightning is probably the most important primary agent of disease in Coconut plantations in Malaya and it seemed possible that lightning effects might be of some importance in relation to rubber tree diseases.

Investigations made during the year have proved conclusively the soundness of this view. Lightning effects in rubber plantations are quite definite and can be considered conveniently under two headings.

(a) Lightning effects in young plantations associated with "Die-back."

(b) Lightning effects in older rubber, (over 4 years), associated with Claret-Coloured Bark Canker at the collar.

The general features associated with (a) have been referred to on previous occasions by other investigators but no exact data have been forthcoming. The association of Claret-Coloured Bark Canker at the collar with lightning effects is an entirely new departure and has not been recorded previously. A comprehensive article on lightning effects and diseases in Coconut and Rubber plantations is ready and has been submitted for publication. The subject matter is of considerable scientific interest because of new findings which lead to clarification of obscure views.

Bud-grafts on Old Stocks.

There are few difficulties attached to the practice of bud-grafting if the stocks are not more than 18 months old. Difficulties arise, however, when well grown stocks, over 2½ years of age are used, because, when the stocks are cut back, a large wood surface is exposed. Budding on four to five years old trees is not uncommon at the present time and when the large stocks are cut back the wood surface exposed may be from 6 to 10 inches in diameter. A wood surface of such dimensions will take years to close over naturally by callus formation and, unless great care is taken, "Die-back" fungi gain an entry and grow downwards to a level below that of the bud-patch. Cases have been found where the "Die-back" fungi had penetrated to ground level and there is no doubt that such cases must succumb finally. The trouble occurred on such a large number of estates that it was considered necessary to issue Standard Instructions for protection of the pruned surface.

Asphaltum-Kerosene mixture for protecting wounds.

In connection with the budding operation, Asphaltum and Kerosene mixtures are the standard recommendations for covering the pruned surface. It has been definitelly proved that the Asphaltum-Kerosene mixtures are not ideal covers for this purpose, for "Diplodia" pycnidia have been demonstrated actually developing in the interior of the Asphaltum-Kerosene layer covering the pruned surfaces. However, this still remains the most useful cover, more especially if used in conjunction with a strong disinfectant solution which should be painted over the exposed surface a few hours before the application of the Asphaltum-Kerosene mixture. Further experiments will be carried on to obtain a better cover, if possible.

Host-parasite relationships in connection with attacks of *Ganoderma pseudoferreum* Wakef. and *Sphaerostilbe repens* B & Br.

The difficulty of correct diagnosis has been experienced by all plant pathologists working on perennial crops. The early symptoms of root diseases of rubber trees are often very difficult to identify correctly and definite aids to correct diagnosis would be welcome. Microscopical sections of the bark tissue of the roots of rubber trees attacked by *Ganoderma pseudoferreum* Wakef. and *Sphaerostilbe repens* B & Br. show typical appearances by means of which a correct diagnosis can be made. These observations will be published when opportunity offers.

Studies on Mouldy Rot disease.

Uu to date there are many gaps in our knowledge in relation to Mouldy Rot disease. There is no doubt that it is the most serious above-ground disease in Malaya, and the situation in native holdings in relation to this disease is extremely unsatisfactory. Further remarks on this point are made later in the report.

In addition to *Sphaeronema fimbriatum,* there are two other species of the same family found on rubber trees. Investigations have shown that the "*Sphaeronema pycnidium*" is not always an imperfect fruit-body containing pycnospores, but is sometimes a perfect fruit body containing ascospores and thus some of the *Sphaeronema* species have been wrongly named and should now be placed in the genus *Ceratostomella.* This finding has been confirmed with one of the rubber *Sphaeronema* species though not as yet with the species causing Mouldy Rot. However, it is fairly certain that a similar finding will be made with the fungus causing Mouldy Rot. Pure cultures have been obtained and, when the required fructifications develop, an attempt will be made finally to confirm the status of the Mouldy Rot fungus. In addition, an attempt will be made to fill in some of the existing gaps in relation to the method of infection and host-parasite relationships.

During August last, arrangements were finally completed for systematic tests on various proprietary disinfectants, which might prove useful in the control of Mouldy Rot. The terms of testing were set out with a view to establishing a "White List" recommended by a committee composed of officers from this Institute and the Department of Agriculture under the chairmanship of Dr. Tempany (Director of Agriculture, S.S. & F.M.S.). In spite of the staff shortage this extra work has been carried on successfully over the last three months and many substantial facts have been obtained as a result. Three additional disinfectants have successfully passed the required tests and several more remain to be tested.

Internal Bark Fissures.

This particular affection was first noted in Malaya in 1929 and attention was drawn to the apparent similarity of the symptoms with Black Stripe disease. Several cases have been examined during the year and they were all found under exactly similar conditions. The estates on which the symptoms of Internal Bark fissures were found had poor bark reserves on their old trees and, for this reason, tapping had been commenced on previously untapped bark, 18 inches to 2 ft. above the bark panels which had been tapped for many years past. The symptoms became noticeable in two months on the newly opened panels. The explanation is still obscure, but the discovery of this association should prove of value if an opportunity for further investigation presents itself.

Bark bursts by formation of rubber pads.

A peculiar feature noted in a field of nine years' old bud-grafted rubber was a fair percentage of bark bursts which were brought about by the formation of a large pad of rubber between the wood and the bark. Recent inspection has shown that in the great majority of cases the bursts originate in close proximity to the places where the ends of the wire cup holders had been inserted into the bark.

The bark was thin and to attach the cup holders firmly the ends of the wire had to be forced deeply into the cortical tissues. In many cases, the cambium, or at least, the rapidly growing inner cortical tissues must have been badly injured. This was proved by the large number of trees which showed knobs or swellings of secondary tissue along the vertical line where the ends of the cup holders had been inserted.

The production of the large rubber pads (one measured 14 ins. by 4 ins. and was 2 ins. across at the thickest part) is difficult to explain. As long as latex remains sterile no coagulation will take place so it may be possible that latex infiltrates for a considerable period until bacteria make an entry ; when this happens, coagulation occurs and as a result of the great expansion, brought about, the bark above is forced outwards and ultimately bursts.

Insect and Animal Pests.

Cockchafer grub plague.

The occurrence of this grub plague has, fortunately, been confined to an area of 40 acres of twelve year old rubber from which it was first reported in August 1930. The caterpillars have been known to attack seedling rubber plants on a small scale but there is no previous record of a mass attack on mature rubber where thou-

sands of grubs have been removed from the soil without any apparent decrease in numbers. The grubs eat away the cortical tissues of the tap and lateral roots down to the wood and a badly attacked tree undergoes successive defoliations while the yield of latex decreases considerably in consequence.

The problem is one of major entomological interest and previous to my appointment various treatments had been tried but all had failed. From the records, it appeared obvious that further attempts along the same lines would be futile and would lead to waste of money. Therefore, after some delay due to various difficulties, arrangements were made to obtain the help of a competent worker in entomology to deal with the problem. Finally, arrangements were completed for Mr. G. H. Corbett, Government Entomologist, Department of Agriculture, S.S. and F.M.S., to take over and control the work until an officer of the Pathological Division of the Institute returns from leave. The investigation is now well under way and results may be expected during 1932.

Grasshoppers.

The common large grasshopper (*Valenga-nigricornis*) is the most troublesome of the grasshopper pests, more especially in young budded areas where a heavy cover crop has been established. One peculiar feature has been reported from three estates ; severe grasshopper attacks in plantations of mixed bud-grafts have resulted in the complete defoliation of the trees belonging to the clone AVROS 152 while all the surrounding trees of other clones were not damaged in any way. This selective attack should not be forgotten in view of the possibility of a locust invasion, and the question of adaptability of insects to food requirements. It is a debatable point as to whether a record of this description should not lead to a recommendation *not* to plant this particular clone.

Orygia turbata.

Records of damage by this insect were obtained from one estate; the control measures recommended proved completely successful.

White Ants.

Numerous requests for advice on treatment in relation to White Ant attacks were received. It is not clearly recognised, even yet, that the only certain remedy for eliminating this pest is total clearing of timber; chemical treatment with the usual Mercuric Chloride solution is only a deterrent and recurrent attacks must be expected.

Mites and Gloeosporium.

Mite attacks on the newly developing leaves of young bud-grafted trees are of common occurrence and the position is usually complicated by the presence of a fungus, a species of *Gloeosporium*. This combination has caused an appreciable amount of damage during the year under review but there has been no opportunity of investigating this problem.

Squirrel damage.

Squirrel damage on branches and on the recently tapped surface has again been reported from several estates. The only practical remedy is shooting. The damage done is definitely periodic and probably can be explained by the absence or presence of the oil-bearing seeds of the rubber tree. When food material in the shape of rubber seeds is plentiful no damage is done, but when this food supply fails the animals commence to feed on the cortical tissues of small branches or on the newly formed cortical tissues of the tapping surface.

General Remarks on Rubber Tree diseases.

This report may be concluded by a few remarks on the disease position in general, during the year.

Pink Disease.

Pink Disease was very troublesome in some parts of North Perak and Kedah during the first half of the year. A circular letter giving details of treatment has been prepared.

Black Stripe.

Black Stripe disease was of little account during 1931 and very few enquiries regarding treatment were received.

Brown Bast.

Similar remarks apply to this disease as for Black Stripe disease.

Ustulina zonata and *Sphaerostilbe repens.*

The root diseases caused by these fungi were of the usual order and were of quite common occurrence. A noteworthy occurrence was a mixed attack of these two fungi ; on several occasions lateral roots were obtained showing the typical symptoms of the two diseases in the same root.

Mouldy Rot.

The special feature in relation to this disease was an arrangement agreed to by the Department of Agriculture to supply planters with disinfectant for the treatment of Mouldy Rot in small holdings adjacent to their estates ; they in turn agreed to supervise the correct mixing. Such an arrangement will help considerably in the control of the disease if it can be worked successfully.

The enforcement of the regulations of the " Pests & Diseases Enactment " is difficult during depressed periods such as the present, for the small-holder is forced to tap continuously in order to obtain money for food. Attention must however be drawn to the present anomalous position which has now arisen. Owing to lack of funds, less attention to treatment of the disease is being given on small holdings. Under such circumstances the " bark position " on infected small holdings goes from bad to worse and an endeavour has been made to improve the condition of the bark by frequent paintings with weak disinfectant solutions, after tapping has been done. Even if painting with a weak disinfectant solution is done conscientiously after each tapping, the fungus is not prevented from further development for, if painting is stopped for two to three days, the fungus become prominent again on all the trees previously affected. After much consideration I am doubtful whether the bark position is improved but the loss of control of the fungus which will result from the adoption of these methods is bound to lead to misunderstanding. From a pathological point of view such control measures cannot be recommended, and the dangers of the situation are all too obvious to those estates which have not yet been troubled by Mouldy Rot Disease.

Replanting Schemes.

A notable feature throughout the year was the interest taken in the possibility of replanting old areas of rubber which, on account of disease losses or through other causes, showed seriously declining yields. There is the not slightest doubt that replanting is within the bounds of practical politics provided that the planting of high-yielding bud-grafted trees could be stabilised and the claimed high-yields guaranteed. A number of estates have undertaken such work on an experimental scale on areas not exceeding 50 acres.

Publications.

The following articles were published during the year.

(a) The Effects of certain Fungicides on the Viability of Hevea Buds—R. P. N. Napper. Journal Vol. 2 No. 4.

(b) A further Note on the Effects of Fungicides on the Viability of Hevea Buds.—R. P. N. Napper. Journal Vol. 3. No. 2.

(c) Test Spraying Experiments on young Rubber Plants—F. Beeley. Journal Vol. 2 No. 4.

(d) Standard Instructions for Protection of pruned Surfaces —A. Sharples & C. E. T. Mann. Journal Vol. 3 No. 1.

(e) Special Bulletin No. 3—The Root Disease Problem on old Rubber Areas in Malaya. A. Sharples & A. R. Sanderson.

A lecture entitled "The Root Disease Problem in Old Rubber Areas" was given before the Taiping branch of the Incorporated Society of Planters and later in the year at the Annual Conference of the Incorporated Society of Planters at Port Dickson.

APPENDIX.

Analysis of Correspondence.

1931.

Subjects.	Letters Received.	Letters Despatched.
Root Diseases ...	107	151
Stem and Bark Diseases ...	154	177
Leaf Diseases ...	121	137
Diseases and Pest Control ...	5	7
Fungicides and Insecticides ...	65	76
Tree Operations ...	3	3
Floods ...	—	1
Injury by External Agents ...	102	122
Brown Bast ...	18	23
Epiphytes on Rubber Trees ...	2	2
Resistance and Immunity ...	2	2
Spraying and Dusting, Equipment ...	30	43
Cover Plants ...	5	6
Diseases, General Treatment ...	12	15
Enquiries on Budgrafting ...	16	18
Miscellaneous ...	8	21
	650	804

Visits to Estates.

January	...	...	...	—
February	...	...	...	12
March	...	...	...	27
April	...	...	...	24
May	...	.	...	23
June	...	...	...	16
July	...	...	...	15
August	...	...	...	11
September	...	...	...	21
October	...	...	...	21
November	...	...	...	19
December	...	...	...	25
			Total ...	214

(Sgd.) A. Sharples,

Head of Pathological Division.

ANNUAL REPORT

CHEMICAL DIVISION.

The activities of the Chemical Division during 1931 have followed the lines adopted in previous years and for the purpose of this report, a review of the work is presented in three sections :— Internal, External and Advisory.

In the two latter sections there has been marked progress during the year, and the results achieved are proving distinctly valuable to the industry.

The laboratory and purely chemical research has, however, made little progress compared with 1930 owing to absence of staff on leave. In the early months, the investigations on latex constituents were discontinued so that Dr. E. Rhodes might commence rubber roadway research which was initiated at the close of 1930. Dr. Rhodes proceeded on leave in May and it was not until Dr. J. L. Wiltshire assumed duty in the middle of September that a resumption of our latex investigations became possible.

Mr. R. G. Fullerton was absent on leave until the middle of October. Mr. J. D. Hastings was appointed Temporary Chemist to continue the rubber roadway research so that the Division has been seriously handicapped by the depletion of staff for the greater part of the year.

The demand for advisory work has shewn a steady and appreciable increase, while the need for visits to estates occasioned thereby has absorbed a high proportion of the time of officers. The extent of this can be gathered from the fact that 222 estates were visited during the year and the Head of the Division was absent from headquarters approximately 25 per cent. of the working days in response to estate requests.

In addition, 12 lectures were delivered in various parts of the country and three conferences were attended. Thus, the time available for laboratory supervision was barely adequate to cope with the increasing demands made by the growing volume of enquiries and requests for the examination of samples.

It is gratifying to be able to record this development and the extended interest in our work is very encouraging, but if we are to cater for similar developments in the next two or three years, it is obvious that the interests of research must be adequately safeguarded, otherwise a time will come when we shall have no results on which to base further advice.

Internal Work.

Separation and Characteristics of Latex Constituents.

Although the results recorded for the previous year were so promising in this branch of our work, it has not been possible to follow them up as closely as was anticipated. The separation of quantities of Quebrachitol and Lipin has however been continued steadily and with the valuable collaboration of the Director of The Research Association of British Rubber Manufacturers we have been able to supply several pounds of Quebrachitol to various enquirers in England while sufficient Lipin has been distributed to secure an encouraging interest in the peculiar properties of this constituent of latex. The part which the minor constituents of latex play in the chemistry of rubber must continue to be merely a matter of conjecture until we possess more information about latex than we have at present, but it is evident from the data already available that the characteristics of rubber are profoundly influenced by its association with comparatively small quantities of non-caoutchouc bodies present in latex.

In this respect, the physical effects on rubber of traces of phosphatides may possibly be turned to industrial use in the handling of raw rubber while the chemical effect of traces of sugars may provide a further insight into vulcanisation. An account of some of our investigations in this direction has recently been published in the Journal (Vol. 3 No. 3), although our attempts to separate and identify the sugars in latex have so far failed to define any sugar other than the galactose associated with the Lipin.

Dialyses of fresh untreated latex at a sufficiently low temperature to prevent biological activity have not disclosed the presence of any dialysable sugar, though the changes in pH (acidity) observed in the dialysate are sufficiently interesting to justify a continuation of this method of investigation.

Towards the close of the year our efforts were mainly confined to a more detailed study of the differences effected by conditions of pH and temperature governing the alcohol coagulation of latex as a means of isolating certain of the serum constituents.

Progress however was dependent on the capacity of the vulcanising factory to examine the rubber obtained from the various coagulations and as there was such a large volume of other vulcanisation testing to be done that it was not possible to proceed very rapidly.

External Work.

The investigations more closely related to the immediate requirements of the industry have embraced the following:—

Variation of Estate rubber.

Quality of Clone rubber.

Efficiency of sheet manufacture.
Drying of crepe and sheet.
The preservation and concentration of latex.

Variation of Estate Rubber.

In close relation to the work described in the preceding section, further progress has been made in the study of variability. From our examination of a comprehensive series of samples collected from first class estates in different parts of Malaya, significant variations in standard sheet were disclosed and the degree of uniformity was shewn to be no better than that recorded for standard sheet examined in 1927.

In order to obtain further data on variability, a number of estates were selected and samples of sheet rubber were taken from random cases of the rubber produced by each estate. The cases examined were representative of the latex collected during August, November and December.

It was found that the rubber from any one estate not only differed considerably from that of any other estate but that an appreciable variation in the vulcanisation properties of the rubber occurred on the same estate over an interval of time.

A report on this work is contained in the Journal (Vol. 3, No. 3.)

The value of the results lies in its bearing on estate rubber production for they indicate the disabilities of first class plantation sheet rubber compared with alternative materials available to the manufacturer of rubber goods. It is probable that few estates at the present time appreciate the industrial importance of producing a standardised and uniform commodity and we consider that the value of the cleanliness of estate rubber is hardly sufficient to compensate the consumer for the irregularities in physical and chemical characteristics which must be allowed for in this grade.

The problem of conferring greater uniformity and introducing improved characteristics in estate rubber has been given considerable attention, both by this Institute and the Ceylon Rubber Research Scheme, and during the past year useful progress has been made. Full advantage has been taken of the close touch existing between the two Research organisations to ensure the free exchange of views and in this connection the presence of Dr. Rhodes in England has proved invaluable as a liaison between the Institute and The Research Association of British Rubber Manufacturers.

An endeavour has been made to prepare trial batches of special types of rubber for despatch to various manufacturers in England but our efforts so far have been handicapped by the lack of suitable supplies of latex and the necessary factory equip-

ment for making approved types of rubber under estate conditions. It is realised that no attempts to introduce alternative grades of rubber can succeed unless the trials are large enough to provide reliable data as to costs and sufficient of the rubber to satisfy requirements of tests by manufacturers. This presents difficulties to a Research Institute in its early development, but there is every indication that the necessary collaboration will be found to enable the Chemical Division to proceed with the work in 1932.

Clone Rubber.

Further to the work which we are doing on the normal variability of estate rubber the examination of clone rubber is important.

Since August a regular examination has been made of the rubber prepared from latex derived from six clones on Pilmoor Estate and a long series of vulcanisation results have been obtained comparing the clones with one another and with rubber from a mixed stand of trees of the same age growing on similar soil in an adjacent field.

Every care has been taken to preserve uniform conditions governing the collection and treatment of the latex but it is apparent that irregularities such as those reported for estate rubber arise in any product of an estate factory and, unless extreme care is taken to eliminate factory variables, the testing of clone rubber is likely to give misleading results.

With the object of avoiding erroneous conclusions we are extending our tests over a number of months and saving the rubber for a further examination after it has been bulked.

The Efficiency of Sheet Manufacture.

The attention of the Division has not deliberately been confined to sheet as opposed to crepe manufacture although it appears in review that very little time has been given to methods of manufacture other than sheet. It is recognised that crepe on the whole suffers from less variability than sheet, owing to its rate of drying and the fact that the serum solids are reduced to a minimum during machining and that blanket remilled crepe is likely to be more uniform than either. On the majority of estates at the present time, crepe manufacture is being abandoned in favour of sheet because the latter is cheaper and simpler to control and requires less expensive machinery.

An ever growing demand from estate managers and agency houses for advice has resulted in considerable progress in relation to problems of sheet manufacture and the economies effected have fully justified the action taken by the Division.

It has been shown that sheet rubber can be machined efficiently at the rate of 2,000—3,000 lbs. (dry) per hour. A more uniform

sheet which can be dried more rapidly is prepared by the use of a battery of at least five and preferably six light machines in place of the old four machine battery.

With the help and collaboration of several Estate Managers and Estate Factory Engineers, the utility of the cascade battery has been demonstrated and the work of machining sheet has been considerably simplified.

It has been shewn that the efficiency of the factory is primarily dependent on methods of handling the latex and the coagulum, and with the very able assistance of one firm of manufacturers, improved factory plant has been designed to reduce factory labour costs to a minimum. In this respect the year's progress has been striking and there are many factories in which capital expenditure on plant alterations has been repaid in a few months by the labour reductions thereby effected.

Given suitable plant, there is no reason why first quality sheet should cost more than 0.25 cents per lb. to manufacture in a correctly designed factory handling 5,000 lbs. per day, and our results tend to shew that where this is attempted by centralising manufacture, the product automatically assumes a degree of uniformity previously unattainable.

Drying of Crepe and Smoked Sheet.

In connection with the investigations made in relation to sheet manufacture, drying problems have received some attention and, with the assistance of the Engineer of one group of estates, some useful data has been collected on smoke-house efficiency and its improvements by alterations to the furnaces or fire boxes.

In a smoke-house adjudged to be efficient by previously accepted standards, the heat distribution is usually poor and on many estates where smoke houses are imperfectly tended and controlled the heat distribution is extremely bad.

Attempts have been made to develop a type of furnace which will overcome this without undue expense, and it is felt that the designs which we now advocate are more efficient heat distributors and less open to fire risks than other internal furnaces. Considerable correspondence on outbreaks of fire occurring in smoke-houses has also taken place. We attribute these definitely to defective ventilation of the smoke-house and the fire boxes, resulting in the production and accumulation of inflammable gases due to imperfect combustion of the wood fuel and the combustion of such gases by accidental sparks from the fires. (vide. Journal Vol. 3 No. 3).

The advantages of underground furnaces and suitable flues in this respect have not yet been fully explored but we are now collecting data from which we hope to be able to provide advice on the best type of furnaces to meet all requirements.

With a view to lowering the cost of smoking, we have advised estates to drip their rubber thoroughly in order to remove as much of the water as possible before placing the wet sheet in the smoke house. The results obtained have been quite successful where the operation has been properly carried out on efficiently washed sheet, but in some cases partially washed thick sheet has been allowed to hang in a badly ventilated place with the result that the drying has been unsatisfactory and the dried sheet has been defective in appearance. The close connection between sufficiently well-machined sheet and efficient drying is frequently overlooked, and in many instances a marked improvement in time and cost of smoking has been effected simply by directing attention to poor work on the sheeting machines.

Air-Dried Sheet.

The year has seen an awakening interest in air-dried sheet and at the Malayan Agri-Horticultural Association Exhibition in August two very attractive exhibits of this type of rubber were shown by different estates. The Chemical Division has adopted the attitude that rubber must be dried before marketing, whether it is in the form of crepe or sheet and whether the latter is smoked or unsmoked, consequently we have taken an active interest in all estate attempts to make unsmoked sheet although we are well aware that the air-dried sheet of former years has fallen into disuse and there is at present no established market for air-dried rubber. It should not be overlooked, however, that air-drying can be applied to a wide range of methods which might prove suitable to estates and it must not be assumed that the characteristics of rubber dried by one method are common to all types of rubber dried without smoking. Our investigations have sought to determine the factors in drying which influence the vulcanising and other properties of the finished product and how the controlling factors can be governed at a reasonable cost.

Different types of dryers have been considered with the object of reducing handling to a minimum, and providing the maximum degree of thermostatic control. The electrically heated dryer shewn at the M.A.H.A. Exhibition in August demonstrated the possibilities in that direction but for general estate purposes it is too costly to run at the present price of electric power.

Among the methods adopted by estates those dependent on the use of steam heaters or hot water circulators appear the most promising and there are now two comparatively large steam plants in regular operation. The product of these is being examined at regular intervals and compared with the other types of air-dried sheet and standard smoked sheet and crepe.

The Preservation and Concentration of Latex.

The growing demand from overseas for preserved latex, with and without concentration, has stimulated interest in alternative preservatives and methods of preservation and concentration.

It has not been possible to progress far in mechanical methods of concentration as we have no concentration plant other than that referred to in last year's report. Exhaustive enquiries have been made among specialists in England but it appears that the patent rights held by the present manufacturers of concentrated latex cover an extremely wide field. Towards the close of the year, however encouraging reports were received from Dr. Rhodes on some trial concentrations carried out in London and it may yet prove expedient for us to install a small experimental evaporator for trials at the Institute.

Laboratory trials with concentration by creaming have proved far more promising. The field here is not so restricted by patent specifications and the prospects for industrial developments are far more conducive to technical research. There is also pressing need for results which will be available to a number of estates now barely able to maintain contracts for latex of high dry rubber content, and the Division is able to report significant progress along lines which should be easily applicable to estate factories.

The economic success of any latex creaming process depends upon the composition and marketable value of the residual serum as well as the concentrate, and one of the drawbacks to any industrial process of creaming which does not result in a total separation of the rubber is the reduced marketable value and the increased difficulty in preparing the rubber in the residual latex which is separated from the cream.

As a result of our investigations, it is now evident that satisfactory sheet of standard quality can be made from "skim" latex which has been preserved for 48 hours if proper control is exercised, which means that in factories where the latex can be stored for a sufficiently long period, some of the crop can be turned into concentrate while the balance can be coagulated and sold as sheet. Up to the present the preference of the market for ammoniated latex and our limited knowledge of the requirements of latex consumers regarding alternative preservatives has prevented any semi-factory scale trials of the laboratory methods. As already stated in connection with the preparation of new types of sheet rubber our own factory has not been adequate for trials of the magnitude necessary at this stage, but it is hoped in the near future to overcome this handicap and to put in hand suitable trials of the method and the products.

The extent of our knowledge concerning preservatives other than ammonia is however rapidly enlarging and with the collaboration of Mr. G. Martin, the Superintendent of Laboratories of the Ceylon Rubber Research Scheme at the Imperial Institute in London we have collected and issued the reports of a number of firms on the relative merits of the latex preserved with soda or potash and arrangements have been made for trial shipments of latex with alternative preservatives.

Points concerning the determination of ammonia and the rubber content of ammoniated latex have been investigated and methods of control established with a view to simplifying factory work and avoiding market disagreements. Our observations indicate that most of the differences between buyers and sellers originate in the sampling.

The evaluation of preserved latex depends upon the reliability of the sampling just as much as it depends on the accuracy of the analysis and we have demonstrated how readily preserved latex creams when standing.

While Mr. Fullerton was in London, useful experience was gained in the methods of sampling and analysis adopted by those representing the buyers' interests. From the observations in London and in Malaya it is evident that insufficient attention is paid to sampling and much of the disagreement occurring at present is very probably due to that cause.

Advisory Work.

The volume of advisory work has shewn a steady increase during the year.

The monthly record of visitors who called at the laboratories during the year for information serves as a useful indication of rate of increase. The total number of visitors for 1931 was 296, the average for the first quarter being 20 per month compared with the average of 35 per month for the last quarter.

An analysis of the correspondence also shews a similar steady increase.

The number of letters received during 1931 was 1,566 compared with a total of 919 and 798 for the years 1930 and 1929 respectively.

A monthly analysis of the letters shews that, during the first quarter, the monthly average was 99 while during the last quarter the monthly average was 151.

This advisory work has been mainly concerned with problems relating to the manufacture of sheet and the handling and preservation of latex ; the exact allocation of the enquiries is shewn in the Appendix.

In connection with these enquiries, 1040 samples were received for examination and report.

Arising out of requests for advice, 222 visits were paid to estates compared to 129 visits during 1930.

A comprehensive series of photographs on estate practice were prepared with the valuable collaboration of Mr. H. Gunnery and the Managers of various estates and a series of cards illustrating typical defects in factory products were prepared for the assistance of estates and agency houses. Pending the advice of the Rubber Trade Association in London these defect cards have not been issued, although they were displayed at the Exhibition held in Kuala Lumpur where a particular feature was the exhibit devoted to factory equipment and the products of good and bad methods.

General.

During the year there has been a marked development of interest displayed in the work of the Division, by planters and their agents in Malaya, and by manufacturers and others beyond Malaya, who are more intimately connected with the consumers' side of the industry. The activities of the Incorporated Society of Planters have been largely responsible for the local interest while the wider interests have been developed through the collaboration of the Research Association of British Rubber Manufacturers.

The establishment of this liaison embracing both sides of the industry is considered extremely important ; its growth will ensure the development of our work along sound practical lines besides providing for the exchange of interests common to producers and consumers of raw rubber.

In this respect, a feature of the year's work has been the number of lectures delivered to branches of the Incorporated Society of Planters on matters affecting the manufacture and sale of plantation rubber. The discussions and visits arising out of the lectures have proved a valuable aid to the Division. During the year twelve lectures were given in various parts of the country, the Head of the Division also attended three conferences and in November and December a weekly lantern lecture was delivered regularly at the Institute on factory practice and costs.

The Head of the Division served as a member of the committee appointed by the Director of Agriculture to consider and report on the marketing of peasant produce and assisted the Co-operative Department in some enquiries concerning the price paid for Kampong (small holdings) rubber. The moisture content of native sheet was determined in a series of samples taken from native dealers throughout the country and visits were paid to the large remilling factories in Singapore in company with Dr. Riebl,

Chief Chemist to the Centraal Rubber Proefstation, Buitenzorg, Java.

The small and decreasing margin between prices paid by consumers for native remilled blanket and standard quality sheet may have an important bearing on our work on the quality of plantation rubber generally and further investigations are therefore proceeding.

The growth in activity of the Division has only been made possible by the unremitting efforts of the majority of the staff and it is to be recorded that while in England Dr. Rhodes voluntarily gave up a very large proportion of his leave to the interests of the Institute particularly in so far as the Chemical Division is concerned.

APPENDIX.

Number of Samples Examined.

Defective smoked sheet	...	...	246
Wet sheet	...	...	29
Air-dried sheet	...	...	50
Vulcanised rubber	...	...	106
Crepe	...	...	129
Water	...	...	53
Hydrometers	...	...	90
Preserved latex	...	...	153
Dry Rubber Content of Latex	...	...	59
Rubber Roadways	...	...	26
Anticoagulants	...	...	36
Slab rubber	...	...	4
Packing	...	...	5
Rubber Paint	...	...	2
Shirlan (Fungicide)	...	...	2
Acetic Acid	...	...	3
Formic Acid	...	...	26
Linatex	...	...	18
Coagulating Tanks and Pans	...	...	2
Acid Proof Cement	...	...	1
		Total	1,040

APPENDIX.

Analysis of Correspondence.

Subjects.	Letters Received	Percentage of Total	Letters Despatched
Anti-oxidants of Latex ...	2	0.13	2
Anti-coagulants of Latex ...	30	1.92	38
Machinery for Rubber Manufacture ...	167	10.66	197
Vulcanising Machinery and Apparatus	3	0.19	3
Vulcanisation of Rubber ...	55	3.51	75
Rubber Seed Oil ...	3	0.19	2
Rubber Oil ...	12	0.79	13
Slab Rubber ...	2	0.13	2
Crepe Rubber ...	28	1.79	30
Crepe Rubber—Lower Grades ...	30	1.92	31
Coagulants ...	41	2.62	48
Rubber Preparation (General) ...	52	3.32	57
Latex ...	43	2.74	40
Latex Preservation ...	117	7.47	134
Latex Concentration ...	40	2.55	34
Latex—Instruments for determining D.R.C. ...	87	5.55	81
Coagulating Tanks and Pans ...	34	2.17	29
Sole Crepe ...	38	2.43	41
Smoked Sheet ...	280	17.88	282
Smoke-Houses	75	4.79	77
Air-dried Sheet ...	108	6.90	132
Water Samples ...	31	1.98	30
Rubber Fillers ...	4	0.26	4
Rubber Softening Agents ...	2	0.13	2
Patents ...	15	0.96	16
Use of Rubber for Pipe Liners ...	3	0.19	4
Miscellaneous ...	115	7.34	113
Rubber Paving for Road Surfacing ...	111	7.09	118
Rubber Film Screen ...	3	0.19	5
Quebrachitol ...	6	0.38	10
New Uses of Rubber ...	15	0.96	15
Rubber Substitutes ...	2	0.13	2
Marketing of Peasant Produce ...	12	0.76	18
Total	1,566	100.00	1,685

(Sgd.) R. O. Bishop,

Head of Chemical Division.

RUBBER ROADWAYS INVESTIGATIONS

Work on the possible application of latex for road-making was started in March 1931 by Dr. Rhodes who proceeded on leave in June 1931. The investigations were subsequently continued by Mr. Hastings, while Dr. Rhodes made a series of visits in England to obtain all the latest information available.

The present report records the state of our work and views at the end of 1931. This amplifies and extends our knowledge and endeavours to summarise the position under three headings.

(a) Rubber compositions made from latex.
(b) The laboratory testing of such compositions.
(c) Rubber road compositions of public interest.

Rubber Compositions made from latex.

A rubber road material made from latex laid on the road as a paste necessitates the incorporation of other bodies as fillers. Some five months were spent on the problems of incorporating mineral bodies and compounding latex with various types of fillers. A number of materials have been made in the laboratory showing possibilities but it was thought that they might not behave in the same way when used in practice. With the co-operation of the Public Works Department a small section of road foundation similar to that used in ordinary road construction was laid at the Institute. A great deal of valuable knowledge has been gained from the use of this section for experimental trials of various mixtures.

It may be pointed out that there are certain difficulties to be overcome in the laying of any paste-like material prepared from latex, the chief of which is the removal of the water content and the behaviour of the material when consolidation takes place. From observation of the drying out of small areas of paste material and their consolidation under pressure some of the conclusions drawn from laboratory work have been proved. Assuming a mix to give an excellent material suitable for use in road making when freed from water it does not seem possible to apply it on the road in such a state. The drying out subsequent to laying causes cracking. Experiments made in Singapore on a large scale show this.

The work on the incorporation of filling materials has been done by hand on a small scale and the experience gained has shown that the uniform incorporation of fillers is not easy. With a thicker paste the difficulty becomes greater. By kind permission of the Wilkinson Process Company we have had an opportunity to use their Werner-Pfleiderer mechanical mixer. Results were not pro-

mising since difficulty was experienced in obtaining a thick paste with the same even consistency as that obtained by hand mixing; which is impossible on a large scale; the Singapore experiment again showed this.

There are some classes of filler that so far have not been investigated thoroughly, viz., the pulp class—paper, rag, fibres, etc. If these are to be tried it is essential that improved facilities for work be obtained. A pulpbeater must be available and some form of efficient mechanical mixer. From the reports written by Dr. Rhodes in England it seems very probable that a small mixer of the ball or pebble type would be suitable for our purpose. Work so far has indicated that until some solution to the removal of the water content has been found the need for investigating the less obvious fillers is unnecessary.

In order to avoid the initial presence of large quantities of water in a mix it might be possible to use concentrated latex. This has been investigated using latex of approximately 60 per cent concentration but, as was anticipated, difficulties in compounding are greater, the latex is unstable and moreover the final result is not much better than the result obtained with ordinary latex; a point is reached both with concentrated and ordinary latex at which introduction of more fillers causes coagulation unless very large quantities of stabiliser are used. Difficulties then arise in connection with setting. The disadvantages of compounding concentrated latex are recognised in those manufacturing processes using thick latices and it is therefore more general to concentrate compounded latex.

Another type of concentrate prepared by creaming with the agents available here has been proved to be unsuccessful. The cream obtained is unstable and separation of the constituent materials takes place. Pastes thicker than those prepared by such means are made by hand. It has not yet been possible to investigate the possibilities of concentrating compounded latex prepared by means of evaporation; experimental plant of the type used in the manufacture of Revertex is needed. The experiments tried so far have indicated the inadequacy of ordinary laboratory means; results obtained were not so satisfactory as mixing by hand.

Preliminary work on the use of vulcanised latex has been studied, vulcanisation being affected by such ultra accelerators as Piperidine pentamethylene dithiocarbamate, zinc pentamethylene dithiocarbamate, etc. For this work the latex has not been compounded with mineral fillers, vulcanisation constituents only being introduced. The effect of time of standing in contact with the vulcanising agent before coagulation and the effect of varying quantities of accelerator have been studied.

Laboratory Testing of Rubber Compositions made from Latex.

Work on the compounding of latex and incorporation of various fillers has led to the need for a testing technique. From the literature available, information received and the results of discussions that Dr. Rhodes has been able to have while home on leave, it is quite certain there is no technique for testing a mix and that *nothing* is known about testing latex base materials for rubber roadways. It is now certain that all available sources of information on the subject have been explored. Accordingly a large amount of our time has been devoted to this side of the problem. It is felt that until we are in a position to test the materials more effectively continued investigation on various fillers is wasted.

In common with all articles containing rubber the life and wearing properties of a rubber roadway mix will depend on the state of vulcanisation of the contained rubber. It is necessary to be able to follow any changes in the rubber that occur with time. The ordinary testing methods for rubber such as permanent set or stress-strain relationships cannot be applied to latex mixes of the type suitable for application to roads. The determination of "free" and "combined" sulphur content and hence vulcanisation coefficient by the usual methods of sulphur determination commonly applied to rubber have been found unsatisfactory. This led to an investigation of the determination of sulphur in rubber by several methods, and the final conclusion that determination by Oxygen bomb oxidation both for ordinary vulcanised rubber and road mixtures was the most satisfactory—incidentally a conclusion arrived at coincident with the publication of an Italian investigator on the determination of sulphur in rubber. Our results show, however, that sulphur content, "free" and "combined", is inadequate as a test of vulcanisation in a road mix. Therefore the possibility of using the rate of changes of swelling in organic solvents such as toluene has been investigated. It has not been possible to deduce anything about the state of vulcanisation of one sample of mix compared with another but it has been possible to interpret swelling results in general terms of vulcanisation for one sample over a period of time.

In conjunction with swelling tests strain-stress relationships have been studied. Results have justified the continued application of swelling tests to the problem; in nearly every case qualitative conclusions regarding the state of vulcanisation have been deduced in agreement with those from tensile strength measurements. It has not been possible to correlate swelling with Permanent set. With a road mix containing bitumen or other constituents soluble in organic solvents such a test is not applicable, and so far there does not appear a line of approach for such materials. Variation in degree of vulcanisation at different depth in the material, added to the

large differences due to very small changes in size and shape of the piece under test make the evolution of a standard test difficult and unlikely.

With regard to abrasion tests several types of apparatus have been tried, the first being of the revolving disc type. These were not satisfactory and a surface abrader was made on the lines of the Kelly machine. After a good trial it has not proved satisfactory. The size of sample required is too large and the flexing during abrasion causes breakage, the area abraded is also difficult to determine. The experience gained during the work has indicated the lines on which a satisfactory machine for mixes of this nature can be made. It must be possible to use a very small piece of material of which the whole surface is abraded and at the present time no machine suitable for our test is available here.

The artificial ageing of compounds has not yet been investigated ; a Bierer-Davis Oxygen Bomb has been purchased for work in connection with ordinary rubber testing technique and its use on roadway mixes followed by chemical methods of following changes in the mix will prove of value and indicate the behaviour of the material under normal ageing. The erection and setting up of the ageing apparatus has required time and much attention to avoid risks and ensure satisfactory results.

With regard to testing work, developments are to be directed towards evaluating a series of routine tests on physical rather than chemical lines. Should a material be satisfactory under such tests as Abrasion, Swelling, Tensile strength, Permanent Set, Hardness or Plasticity, followed by chemical examination by acetone and toluene extractions before and after accelerated ageing, we are better fitted to predict its behaviour under actual road conditions than to use merely the test of service. The evaluation of a test for shrinkage and its rate at different temperatures is also a necessity for a paste material.

Rubber Roadway Compositions of Public Interest.

Investigations on the use of bitumen emulsions in connection with latex have been carried on. While it may be possible that a latex-bitumen emulsion, containing vulcanising ingredients or using vulcanised latex will be an improvement on the ordinary bitumen emulsion now in use for surfacing roads it is not possible that such a combination will effect absorption of vibration or confer other properties on a surface such as we are seeking. Until recently it was not possible to obtain an emulsion containing low penetration bitumen ; reports from bitumen emulsion manufacturers now indicate that these are possible. A "Premier" paste mill has been installed

and work on the preparation of bitumen emulsions of low penetration in combination with latex will be carried out. The results so far have not been successful, the types of bitumen available being limited ; supplies of a wider range are now procurable.

Latex cum Bitumen Emulsions.

A bitumen emulsion known as "Aleric" has been investigated in connection with its use for mixing with latex. Laboratory tests have shown it to be very similar in behaviour to Colas, a bitumen emulsion prepared by the Asiatic Petroleum Company. Test strips were laid on the Kuala Lumpur - Port Swettenham road at Petaling Bridge using the proportions recommended by the inventor—75 per cent. of Aleric and 25 per cent. of latex by volume. The results were not satisfactory and a further test on a larger scale, using a different method of application, was laid. It is yet rather early to say much about the second trial as traffic has not been very heavy over the area owing to road repairs and a subsequent rubber roadway experiment on the other side of the bridge, but it appears that the mixing of latex with bitumen already emulsified yields too thin a product, while the resulting surface is too elastic, the plastic nature of the bitumen being masked and causing the layer to be peeled off rather readily.

Singapore Experiments.

A visit was made to Singapore to inspect one of the experimental areas of latex paste being laid, and the subsequent behaviour of the material has been watched. The mix used was of the same general type as we have been working with for some time past, in fact there cannot be much variation since the problem is one of incorporating with latex some kind of cheap filler or fillers. The drying of the paste was only obtained at the expense of contraction and resultant cracking. Subsequent consolidation by rolling appeared to seal up many of these but the result was not satisfactory. The possibility of water penetration must not exist if the product is to be successful.

Vulcanised Rubber Sheets.

Following the favourable report on the "Silent Roadway" experiment carried out at Lahat by Messrs. Kendall and Graham in which strips of thick rubber matting were laid, three pieces were purchased from the makers, the Kinta Rubber Works, Ipoh, and with the co-operation of the Public Works Department were laid at Petaling New Bridge. A series of photoghaphs were taken during

the laying illustrating the method of anchorage and the grading up of the road on both sides to ensure a level finish. A traffic census is being taken, the results of which are not yet available.

In addition to the trials recorded above, several samples of material for rubber road making have been sent to the Institute for examination and report. The tests which have been carried out have shown them to be unsuitable.

The work on the incorporation of fillers into latex and the preparation of pastes has indicated that this method of application has little possibility unless some form of dehydration can be effected before the application of the paste to the road ; this infers coagulation and the consequent loss of anchorage since the paste mixes cannot be laid once coagulation has set up.

Conclusions.

The work on latex containing smaller percentages of mineral matter showed that such a mix when creped could be laminated successfully. We have also the commercial use of Linatex as another example of a rubber material carrying a small percentage of mineral matter prepared direct from latex. Further investigations are now being undertaken to explore the possibilities of more heavily filled latex compositions on the lines adopted for Linatex. The paste mill recently installed should enable us to investigate such preparations on a scale sufficiently large to permit service tests and, from the information we have gained from our preliminary work, we hope to be able to secure anchorage of a partially coagulated filled material which can be tamped into the road foundation and built up in much the same way as Linatex to form a carpet similar to the Silent Roadway strips now on trial.

While the work so far has not produced any positive result, we have considerably advanced our knowledge for the reasons of failure. That the chances of success were small was pointed out at the commencement. Further work has shown that the difficulties encountered and the many problems concerned fully justify that statement.

(Sgd.) J. D. Hastings.

Chemist.

ANNUAL REPORT

EXPERIMENT STATION.

The total area of the Experiment Station, situated in the Sungei Buloh Forest Reserve, 17 miles from Kuala Lumpur, is 2055 acres.

The following details show the development of the Station, at the end of 1931.

ACREAGE STATEMENT.

Planted	...	784¼ acres.
Cleared for planting	...	9 „
Cleared, not to be planted	...	35¼ „
		828½ „
Elephant belt	...	96 „
Building site	...	64½ „
Total area opened	...	989 „
Jungle reserve	...	1066 „
Total area under application	...	2055 „

DISTRIBUTION OF PLANTED AREA.

Botanical Division	...	551½ acres.
Pathological Division	...	105 „
Soils Division	...	172 „
Building Site	...	64½ „
		893 „

CLEARING.

Area cleared in 1928	...	200 acres.
„ „ „ 1929	...	475 „
„ „ „ 1930	...	304 „
„ „ „ 1931	...	10 „
Total		989 „

Forest Reserve Area. Work on an area which had previously been demarcated for clearing of timber was held up, as the question of the suitability of the reserve area for planting came up for discussion; the good cut timber remaining was taken over by the Station, and the contractor was paid off.

The digging over of the low land adjoining the Sungei Payong, on the south side of the main road to Sungei Buloh, was completed. Digging was done to 3 feet and all timber and roots removed; an application of lime, at the rate of 2 tons per acre was applied, and dug in, and a green cover was sown.

Two isolated plots have been made in the main Forest Reserve, each 5 acres in area, and these have been planted up with stumps, for budding with *Hevea Spruceana.*

In Block 14E (10 acres on the western side) where stumps and timber were left, and where the area was originally planted 30 ft. × 30 ft. the plants were budded for transplanting, and the area was then re-lined at 20 ft. × 20 ft. Owing to change of lining, clearing of stumps had to be undertaken. No other clearing work was done during the year.

LINING & HOLING.

Block.	Area.	Spacing.	Dimensions.	Cost per hole
14E	20 acres.	20 ft. × 20 ft.	3 ft. × 3 ft. × 3 ft.	4 cents.
20	25 ,,	15 ft. × 15 ft.	2 ft. × 2 ft. × 2 ft.	2 ,,
25	16 ,,	18 ft. × 18 ft.	2 ft. × 2 ft. × 2 ft.	2 ,,
Jungle Plots	10 ,,	22 ft. × 11 ft.	3 ft. × 3 ft. × 3 ft.	4 ,,

PLANTING.

Block 14E. (East). (Botanical Division).

Planted in December with seedlings of the Pilmoor Clones A44, B50 and B58 and plants grown from seed obtained from a commercial budded plantation. The seedlings were tested in the nursery with Cramer's testing knife, the aim being to investigate this method of nursery selection of high yielding trees.

Block 14E. (West). (Botanical Division).

Planted with seedlings derived from artificial pollinations between Glenshiel Clone 1 and a number of the Pilmoor Clones, and seedlings from isolated seed gardens. Buddings of the parent clones form the boundary rows between the several plots of crosses.

Block 20. (Botanical Division).

This block, originally laid out by the Pathological Division, was handed over to the Botanical Division in June 1931. The original planting was 30 feet by 30 feet. Interplanting with basket plants at 15 feet by 15 feet was completed in November over an area of 22 acres. Budding, on the duoclone system, will be carried out in this area.

Block 25. (Botanical Division).

Planted with seedlings from (a) selected mother trees used for the work on establishment of new Malayan Clones (Block 15) and (b) seedlings from established clones.

Isolated Jungle Plots in the Forest Reserve. (Botanical Division).

Planted with good stumps at three per hole for ultimate budding with *Hevea Spruceana* in Block A. *Hevea Spruceana* and *H. Brasiliensis* (selected clones) in Block B.

I am indebted to the General Manager of Kepong Estates Ltd., for the supply of the selected planting material used in these plots.

Summary of Field Planting.

Block.	*Area.*	*Spacing.*	*Material used.*
14E (East)	9 acres	20 ft. × 20 ft.	Seedling crosses and buddings for control.
14E (West)	10 „	20 ft. × 20 ft.	Clone seedlings to test Nursery selection methods.
20	22 „	15 ft. × 15 ft.	Basket plants from Puchong Estate seed.
25	45 „	18 ft. × 18 ft.	Selected seedlings from mother trees and clones.
Jungle Plots	10 „	22 ft. × 11 ft.	Seedling stumps from Kepong Estate.

Nurseries.

A regular round of sulphur dusting has been carried out in all the nurseries and where growth has been slow, fertilisers have been applied, to advance the rate of growth, so that budding could be accelerated.

The nursery in Block I (South), which had been used for supplying, was cleaned up and divided into four plots, with two manured areas, and two controls. Puchong Estate seeds were germinated and planted.

Block 1. Clone Collection Nursery. (Botanical Division).

Planting was completed and the whole area received a light forking. No further manuring was done.

Block 1. General Nursery.

This nursery was completely replanted with Puchong Estate seed. Manuring experiments are in progress in this nursery.

Block 4. Multiplication Nursery. (Botanical Division).

Multiplications of all tested clones received at the Station are now established in this nursery.

Old nursery beds have been replanted with seedlings for future budding.

Multiplication of budwood of 197 Estate mother trees selected for trial in Block 15 has been carried out in this nursery.

Block 12.

Part of this block was laid down with 40 nursery beds, which were treated with various disinfectants. Good results were observed for small dressings of lime (up to 2 tons per acre). Larger dressings were not so good and heavy dressings of substances like sulphur were very definitely harmful. The entire block will now be taken in for a "forestation" experiment, and as a first step the vacant areas will be closely planted with seed and seedlings.

Block 17.

A mulching experiment was carried out on this Block and height measurements were taken at intervals.

Block 25. General Nursery (Botanical Division).

Seed from a large number of proved clones has been collected from many sources and planted. The material will be used for continuation of nursery selection work and general experimental work on budding.

Further "twin" seedlings have also been planted in this nursery.

In all young nurseries a regular dusting with sulphur for the control of mite and leaf diseases generally has been carried out. Fertilisers have been applied on nurseries in which it is proposed to bud plants for transplanting in 1932.

Manurial Treatments.

Block 6. (Soils Division).

Laid out as a Latin Square, with 5 manured plots and 1 control, replicated 6 times. Two manurial applications have been made this year. Height and girth measurements have been taken and results are being published by the Soils Division.

Block 17A. (Soils Division).

This Block which consists of green cover and control plots from South to North is subdivided into 5 strips running East to West.

These plots have been treated quarterly with Cresite and Magnesium sulphate. The fertiliser has made the cover grow luxuriantly, and the clean weeded plots show much higher growth of rubber than those with cover.

Block 18. (Botanical Division).

The growth in this Block, which was very poor, necessitated an application of manure, and a mixture of 50 per cent each, of Sulphate of Ammonia and dried sand, at the rate of ¼ lb., per tree was applied. This has accelerated the growth quite noticeably.

The cost of manure, labour etc., was as follows :—

Area manured 72 acres planted 20 ft. × 20 ft.

Sulphate of Ammonia	...	$73.60
Mixing with sand	...	2.40
Application	...	10.20
		$86.20

Average per acre on 72 acres = $1.19.

Block 23.

The 10 acres mentioned in the previous year's report, at the north eastern end of this block, have proved interesting. Lime at the rate of 1 to 5 tons was applied with control plots. The growth of the rubber and catch crops (pineapples, coffee and tapioca) is noticeably poor in the plots to which 3 to 5 tons of lime were applied. *Fomes lignosus* was very prevalent also in these areas.

Catch Crop Experiments (*Block 23*).

During the latter part of 1930, in Block 23, an area of 19 acres of coffee, 11 acres of pineapples, and 13 acres of tapioca, with control plots, was laid out between the rubber. The tapioca has been harvested and a crop of 30.5 piculs per acre was obtained. Cost per acre from pulling to replanting, including carting of tops to jungle amounted to $8.63 per acre. The area was replanted and a second crop will be removed in 1932.

Noticeable variation in growth of the pineapple plants is to be seen, but no crop is yet available for picking.

The coffee has been badly attacked by a leaf blight and also by grasshoppers, which has retarded the growth considerably. Spraying with lead arsenate, every ten days, appears to be checking these pests.

A coffee nursery has been made for supplying these areas.

Roads and Bridges.

426 chains of road were upkept, i.e., weeded, edges trimmed and slashed, at an average cost of 10 cents per chain per month.

The hill road in Blocks 19 and 24 has been sanded, but no heavy upkeep has been necessary and the road has stood up well.

In Block 18, 65 chains of road were completed and sanded at a cost of $1.42 per chain.

The road work is now completed and no field is farther than 20 chains from a road, which facilitates inspection and easy access for visitors.

The two (3 ft. 6 inch) road culverts, at the 16th and 17½ mile stones, in the Sungei Payong and Sungei Pelan under the main road through the Station, were lowered 4 feet to effect better drainage. Heavy work was experienced with the double culvert in the Sungei Pelan.

The total cost was $900/-, of which half was paid by this Station and half by the Public Works Department.

I have to thank Mr. Roberts, the Executive Engineer for his assistance in this matter.

The main road to the Station and to Sungei Buloh from Batu Tiga on the West is completed and the distance to the Experiment Station from Klang is now 16 miles.

Drainage.

Due to the lowering of the culvert mentioned above, it was found possible to deepen the Sungei Pelan, through Block 17, the jungle strip, and in Block 22. The drain cut in Block 23 in 1930, which was unsatisfactory due to numerous slips, was also recut.

A total drainage of 133 chains was thus completed, and an extension carried out along the north end of Block 14. The drain is 17 ft. × 6 ft. × 1 ft., and, as the soil is sandy, grass was planted from the water edge up the banks on either side for 18 inches. The remainder of the bank had a low cover crop dibbled in and this has stood up well, despite heavy rain. The cost of this drain including grassing, was $4.39 per chain.

In Block 18, at the southern end, where the Sungei Payong enters the jungle reserve, there are double culverts under the road and these have been causing a lot of trouble due to heavy silt deposits brought down from Block 25. Despite the fact that the Sungei Payong was cleaned inside the jungle for 30 chains, these deposits could not be removed sufficiently fast to stop flooding of the swampy area in Block 18. On the suggestion of Mr. Riches of Hawthornden Estate, a system of flapping sacking screens was put in every chain and these are proving most satisfactory. A notice-

able deepening of the stream above and below this culvert is to be seen.

In Block 2, the drain from the lines was recut, and the inverts relaid. The main drainage system has been upkept at a cost of 16.4 cents per chain.

Terracing, Silt Pitting and Bunding.

No new terracing of the hill in Block 24, has been done. A monthly patrol has been used to repair storm damage. The silt pits and bunds in Block 23, where the tapioca has been planted, were damaged when the catch crop was removed and had to be remade. A total of 46 chains was completed at a cost of 14.5 cents per chain. Contour bunds were constructed in Blocks 16, 17 and 19 on the sides of the small ravines and in Block 25. The bunds are 2 ft. 6 inches high and cost 19 cents per chain.

In Blocks 6, 8, 9, 10, 13 and 18, 1 chain square bunds 2 feet high were remade and cover planted on the bunds.

Cover Crops.

A very noticeable die-back of Vigna occurred in all the Blocks in which this cover was planted and consequently high weeding costs were experienced. These areas have all been supplied with a mixture of *Calopogonium mucunoides, Pueraria javanica* and *Centrosema pubescens.*

In Block 16, which is under Calopogonium only, this cover died back in patches and has been supplied with *Centrosema pubescens.* The 10 acres in Block 17D, reserved for covers only, has proved conclusively that *Centrosema pubescens* and *Crotalaria anagyroides* are the most suitable low and bushy covers respectively.

Pueraria phaseoloides and *Indigofera endecaphylla* show the second best growth. It was found impossible to obtain some of the covers recommended for the demonstration nurseries in Block 13A. A strip 1 chain wide, divided into half chain plots has been replanted near the road with all the available covers for demonstration purposes.

The remainder of this area has been planted with rubber, and this area will have only the best known covers planted for cultivation and treatment on a commercial basis.

Soil Wash Experiment with Cover Crops.

In Block 24, an area of 3.6 acres was selected, where the face of the hill was most uniform, and was planted as shown below. Each plot is 1 chain by 4 chains.

(1) *Calopogonium mucunoides.*
(2) *Pueraria phaseoloides.*

(3) *Indigofera endecaphylla.*
(4) *Crotalaria anagyroides.*
(5) *Vigna oligosperma.*
(6) *Centrosema pubescens.*
(7) *Tephrosia candida.*
(8) Grasses only.
(9) Control. No grass or cover.

On each terrace and between terraces on each respective strip, a row of posts 5 ft. long, were buried to a depth of 2 ft. 6 inches. Soil wash measurements are to be taken. The cover plots are divided down the face of the hill by strips of Citronella grass.

In Blocks 10 and 21 the existing covers have two or three rows of controls between. These covers are now being planted and allowed to extend, till the whole of the area will be under covers.

The control strips in Block 23, between the various catch crops have been planted with Centrosema and Calopogonium to provide optimum conditions against the plots under the catch crops.

Cultivation.

The Calopogonium, which was spreading in the coffee areas in Block 23 and retarding the growth of this crop, was dug in over an area of 7 acres. This work cost $3.83 per acre.

Block 19. During the first part of the year, the plants were ring weeded to 3 ft. diameter monthly. In April, it was decided to stop this, and the grasses were dug in alternate monthly within a circle of 3 ft. diameter. This work was also carried out in Block 17C. The planting on these Blocks is 22 ft. × 11 ft., and 11 ft. on contours, and the cost of this work averaged 75 cents per acre alternate monthly.

Pests and Diseases.

A noticeable decrease in the number of rats has been experienced. Grasshoppers are very prevalent and cause considerable damage to young plants but spraying with lead arsenate is minimising their attacks.

In Blocks 7 and 8, two rows of each of the following covers, Lamtoro (*Leucana glauca*) and Crotalaria, were pulled out. Rows are being clean weeded to see whether these covers were acting as a host for *Fomes lignosus.*

Root diseases are chiefly confined to *Fomes lignosus.* The Pathological Division has instituted a six-monthly tree to tree inspection of all trees.

Trees affected with collar attack are treated with one gallon of 2 per cent copper sulphate. This treatment seems effective if

the attack is noticed early and costs on an average 8 cents per tree.

For the treatment of *Fomes lignosus* on the roots, and when the plant is dead, a hole 4 feet in diameter and 3 feet deep is cleared of all roots and timber and then an 8 feet square is dug over to a depth of 18 inches and a 3 feet isolation trench is dug round the area. The treated area is then sprayed with 2 gallons of a 5 per cent solution of copper sulphate.

The cost of this work, including chemicals, average 65 cents per square and in cases where timber and stumps have been left is $1/- per square.

Various other chemical disinfectants have been tried but, at present, copper sulphate solution appears to be the cheapest and best.

Height and Girth Measurements.

Measurements have been taken at regular intervals on Blocks 2, 3, 4, 5, 6, 7, 8, 9, 11, 13, 14F, 14C and D, 17 and 24.

Isolated Plots in Jungle Reserve.

During the year, approval was given for the acquisition of two isolated jungle areas in the forest reserve adjoining the Experiment Station for experimental work with *Hevea Spruceana*.

Two separate areas of 5 acres each were allocated to us by the State Forest Officer and were prepared as follows.

The areas were rentised on all four sides, and were then lined, one area 22 feet from North to South, and one 22 feet from East to West. Rentis, six feet wide, were cut and cleaned up along each planting row ; good stumps, three to a hole, were planted 11 feet apart along the rows. The belukar (secondary jungle) between the rows was slashed down to three feet, and only large jungle trees were allowed to remain. A supply of material of *Hevea Spruceana* is established in Block 4 multiplication nursery.

Weeding.

Normal estate weeding has been done over the year. Owing to certain experimental areas being manured, costs for some months of the year were high. The average cost of weeding for the year was 52.6 cents per acre per month.

Budding.

Budding operations, under the direction of the staff of the Botanical Division, have been carried out in the following experimental blocks.

Block 5. Clone Trial Experiment. Supply budding of seedling stocks planted where the original buddings have been lost by root disease, etc.

Block 10 (including 10A). Influence of the scion on the yield of the stock. Budding was carried out at ground level, 1 foot, 2 feet, 3 feet and 4 feet, using 5 different clones.

Blocks 14A and *14B.* Budded with material from the 1929 crosses of Pilmoor Clones in Block 16.

Block 15. (1) Clone collection. (2) Establishment of new clones. This block is divided into plots of 30 trees each. In each plot 20 trees are budded from the clone or mother tree selected for test and 10 trees are budded with clone AVROS. 50. Buddings from 34 clones and 150 mother trees have been made so far.

Block 17 (*A and D*). Experiments on mixed planting of buddings and seedlings. Budding with six clones in regular succession in alternate rows.

Block 17 C. Duoclone planting. Alternate plants are budded with an old well tested clone and intermediate plants with a young but very promising clone.

Blocks 19 and 24. Monoclone planting. Rebudding of failures and supply plants was carried out in June. Budded stumps were transplanted where necessary.

Block 2. Mixed budding with a number of well tested clones (polyclone planting). Budding was carried out with seven clones in regular succession along the rows.

Block 25. Buddings of the 1928 seedling crosses were transplanted from Block 4 nursery.

Budding operators have been employed mostly on the Station, except in the case of estates on which experiments are being run in conjunction with the Station.

Rates have been reduced as follows:—Mandor $1.50, Chinese budders $0.80, and Tamil budders $0.55. This is an inclusive charge for work from 6 a.m. till 6 p.m. No bonuses have been paid to labourers this year for final successes.

Budwood for Block 15 was budded in Block 4 nursery and is now used for budding in this field.

The high budding has proved successful; results for this work, and also for the work done in Block 21 where various dates for opening and cutting back were employed will be published by the Botanical Division.

Test-Tapping.

70 trees in Block 4C were test-tapped. Records have been kept by the Botanical Division.

RAINFALL.

The rainfall for the year was 97.13 inches as against 96.26 for 1930. The rainfall was more evenly distributed.

BUILDINGS.

During the year, the following buildings were erected.

(1) Field Laboratory.
(2) Electric Light Engine and Dynamo House.
(3) Oil and Fuel Store.

Water Supply. The water supply from the jungle is satisfactory, and there has not been any sign of water shortage during the past year. The catchment area in the jungle has been rentised, and reserved for us by the Forest Department.

HEALTH.

Health has been good during the year ; there were only two hospital admissions among staff, both of which were operation cases. The 40 acres in the Sungei Payong area, now known as Block 25, has been cleaned up and no mosquito larvae are to be found there. During the year, there have only been 30 cases in hospital amongst the labourers.

	Fever	Maternity, wounds, etc.
Hospital cases ...	6	24

Anti-malarial Work. Upkeep work over the 1,000 acres opened up has been done regularly and the average monthly expenditure for labour and oil has been $103. Most of the hospital cases were relapses, especially so in the case of old coolies, who were badly infected by fever in 1929. Oiling is done every 7 days during wet weather and every 10 days during dry spells.

GENERAL.

Mr. H. G. W. Matthews joined the Staff on the 1st February and has assisted me greatly during the year. It is a pleasure again to record my thanks to the Asiatic Staff for their assistance and the careful manner in which all the recording etc., has been carried out. Many visitors have been taken round the Station, and interesting discussions have been forthcoming, which have assisted me in settling several difficult points.

Mr. D. S. Gardner, Visiting Agent, proceeded on leave in July, and Mr. Alex. Douglas, has visited the Station every two months since.

I am indebted to these two gentlemen for their help and guidance during the year.

(Sgd.) H. W. FOSTON,
Manager.

ANNUAL REPORT

by

FIELD OFFICER, JOHORE.

Introduction.

The first part of this report covers the period up to September 18th on which date the writer proceeded on leave. Mr. A. Moore was appointed to act as Field Officer in Johore during the remainder of the year.

Advisory Work.

Advisory work has occupied the greater part of the Field Officer's energies, though regard has been paid to experiments conducted within the State. In this connection it is to be regretted that one experimental area on which much care in lay-out had been expended by the Soils Division of the Institute has sustained an alteration in tapping system which has rendered the records, till then carefully taken, of little value. During the period, visits numbering 118 to 74 separate estates or rubber areas in all districts of the State were made, while 529 letters were despatched.

Large Estates.—89 visits were made to 54 separate estates, and 228 letters were despatched to estates and to individual planters. 120 letters were despatched to Government officers, business houses and others.

Medium and Small Holdings.—Advisory work among small holders is conducted through the Principal Agricultural Officer, Johore, and special advisory publications are distributed in this way. Close touch has been maintained with this officer, and in addition, 29 visits to 20 separate small-holding areas have been made.

Visits to Kuala Lumpur for study at the Institute were made, and a number of visits to estates in the Federated Malay States, after consultation with the Heads of Divisions at the Institute. On the occasion of the M. A. H. A. Exhibition in August, 1931, the writer was on duty, and a number of Johore planters attended. Both the Regent of Johore (Tunku Mahkota), and the Tunku Aris Bendahara visited the Exhibition, saw the Institute's exhibit, and were put in touch with the Research Officers present, but no group of Malay headmen from Johore attended, as in 1930. If possible, this arrangement should be re-established, as much interest was aroused, and it is only through such groups of influential Malays that the larger shows are of value to the small-holders in Johore. Unfortunately

neither the Agricultural Shows at Muar or at Kukub could be held during the year, but there is some possibility of holding shows in 1932, and the Institute's exhibits would be of great interest in the predominantly small-holding coastal districts.

Lectures.

Lectures on Oidium leaf disease of rubber were given before considerable gatherings of planters at Rengam and at Batu Anam, when sulphur-dusting methods were also displayed. In addition, lectures by Research Officers were given, and visits paid to the State by the Director, Chief Field Officer, Head and another member of the Chemical Division and a Field Officer from Headquarters.

Soil Treatment and Improvement.

Interest in soil conservation and drainage and the use of cover-plants and fertilisers is on the increase. The use of fertilisers in bringing on young plants for budding is now standard practice.

Use of Improved Planting Material.—The use of improved planting material continues, and much interest is shown in the Clone Trials undertaken at the Institute's Experiment Station.

Diseases and Pests.

Leaf Diseases.—More normal weather conditions than those of 1930 were experienced and, though Oidium leaf-disease was reported from two new areas (Batu Pahat and Kota Tinggi), damage from this disease has been considerably less in the Muar and Tangkak districts in the current period than last year. *Helminthosporium Heveae* (Bird's Eye Spot Disease) has again been common all over the State on young plants, and mites have also been commonly found.

Pink Disease.—This disease has been reported in a few cases only, and has been correctly treated.

Mouldy Rot.—The heavier rainfall experienced has resulted in conditions favourable for the spread of this disease, which has been reported from all the larger planting districts. Small holders are continuing their efforts to check the disease, under the advice of the Department of Agriculture, and more standardised methods are now in use.

Root Diseases.—*Fomes lignosus* has caused a great deal of loss in young rubber areas, particularly on light soils, and also on some of the older rubber, while *Ganoderma pseudoferreum* is commonly found in older areas and on heavy soils.

Miscellaneous Pests.—Grasshoppers have done much damage over small areas of a few new clearings, but control measures soon have the required effect.

Manufacture of Raw Rubber.—Great interest is shown in the work of the Chemical Division with regard to increasing the efficiency of manufacturing methods, and in the possibilities of air-dried instead of smoked sheet. A number of the larger estates continue to manufacture crepe but, in general, attention is principally paid to sheeting methods. Preserved latex shipments are now steady from several estates, and the "Revertex" plant for concentrating latex is in use periodically on one estate. A continuous sheeting plant has recently been installed on one estate. The Information Cards issued by the Institute are of the greatest use to all manufacturing raw rubber.

Close liaison has been maintained with the Institute during the period under review, a total of 181 letters having been despatched in this connection.

(Sgd.) N. C. Jenkins,
Field Officer.

REPORT

For period 23rd September — 31st December, 1931.

Advisory Work.

The work of the Field Officer, Johore, has so far been almost exclusively advisory. Advice is given based on information supplied by the Research Divisions of the Institute, and when necessary special problems are referred direct to the Research Officers. The present very stringent financial conditions in the planting industry have somewhat affected the scope of the advisory work, Advice is rarely asked, or acted upon, in cases where any appreciable expenditure is required, even when such expenditure is certain to result in considerable profit. This applies more particularly to such problems as soil conservation, where any work done does not produce an immediate tangible result. On the other hand advice on how to effect economies, however small, is eagerly sought. This is particularly evidenced by the interest being taken in labour saving devices in the factory. More recently the forestry method of cultivation has attracted attention, not so much for its possible value on scientific grounds, but chiefly because of the saving in labour that it offers.

Through the Principal Agricultural Officer, Johore, constant touch is maintained with conditions on small holdings, but most of

the Field Officer's work consists in advising large estates, both Asiatic and European. The visiting work during October, November, and December is summarized as follows.

36 visits were paid to 30 large estates.
3 „ „ „ „ small holdings.
4 „ „ „ „ business houses, etc.

A total of 38 advisory letters were despatched to 30 different estates but as most of them dealt with more than one subject, the following analysis is attached to show the type and number of questions dealt with in this correspondence. Most of the letters are in confirmation of advice given during estate visits. A few are replies to letters of enquiry.

Budding	...	9
Tapping	...	4
Latex Preservation and Concentration		3
Sheet & Crepe Manufacture	...	3
Smoke Houses	...	3
Machinery & Factory Work	...	3
Root Diseases	...	4
Tapping Panel Diseases	...	3
Manuring & Replanting	...	8
Leaf & Branch Diseases	...	9
Soil Conservation & Drainage	...	3
Cover & Catch Crops	...	5
"Forestry" Methods of Cultivation	...	2
		59

In addition to the above, many letters were sent direct from the Institute to estate in Johore, and are included in the Reports of the Research Divisions.

The research work of the Institute has been closely followed, and it is hoped to maintain touch by spending a few days every three of four months at the Institute and Experiment Station. Observations made in Johore that are of any interest are reported to the Research Divisions. These letters, together with letters of enquiry addressed to various Divisions, amounted to 45 during the period under review.

Experimental Work.

A complete series of measurements of girth and bark thickness were made during October—November on a large scale estate manurial trial, covering some forty acres. Previous measurements had been made 2½ and 2 years ago.

The recent observations amplify the earlier ones, and appear to be of some value both to the Institute, as scientific records, and to the estate, as a guide for future manuring.

Two other estate manurial experiments are being watched, but as these have only just been laid down no results have yet been obtained.

Various estates have agreed to conduct experiments in high budding, forestry methods, cover crops, catch crops, factory practice, periodic tapping, etc., and the progress of such work will be carefully noted.

The observations to determine the rate of bark consumption on small holdings, carried out by the Department of Agriculture, are also being followed.

General Observations.

There is a definite tendency amongst planters in general to take a greater interest than formerly in new ideas. Unfortunately, lack of funds prevents these ideas from being tried out at present but there appears to be little doubt that a revival of prosperity in the rubber industry will be followed rapidly by changes and improvements in planting practice.

The following notes are observations on general matters, and also serve to indicate to some extent the lines along which interest is being developed.

Botanical.

High budding of trees up to 5 or 6 years old with high yielding material, as a means of improving the yield of the stock, is being tried in a small way on two or three estates where the work can be done cheaply and conveniently. Another estate is intending to conduct an experiment using a variety of clones on some 900 trees, and it is hoped that eventually results of considerable value will be obtained.

On estates which are opening up new areas, budgrafting is now customary and is even being adopted on smaller Asiatic estates.

Interest in periodic tapping systems has been renewed, with a view to obtaining maximum yields from minimum consumption of bark. At present the ordinary alternate daily tapping is the rule, but some estates are experimenting with daily tapping in alternate periods of a month or six weeks. On many older or poor yielding areas selective tapping is practised as being most economical.

Chemical.

Improvements are being made in factory methods, especially when slight alterations can effect considerable economies, as is

frequently the case. The efficiency of smoke-houses is being increased and efforts are being made to turn out a greater proportion of first class rubber.

Enquiries have been received on the subject of air-dried sheet, but these have been more or less tentative, and so far little is being done. More interest is being taken in the exportation of preserved latex. Another "Revertex" plant for the concentration of latex is being set up in the State and another large estate is proposing to ship ammoniated latex in large quantities in the near future.

Pathological.

The incidence of pests and diseases appears to have been quite normal.

A slight outbreak of *Oidium Heveae* occurred in South Eastern Johore during the dry weather which followed the August wintering (a partial wintering in August is usual in this part of the country). It was not serious and disappeared when the wet weather set in.

Root diseases in old rubber are frequently neglected, but the recent bulletin on the subject published by the Pathological Division of the Institute directed attention to the problem and more care may be given to treatment in future. Most estates with areas of young rubber are alive to the dangers of *Fomes Lignosus,* and in general a fairly careful control is maintained over this disease.

Mouldy Rot does not appear to be common on large properties, but many small holdings are seriously affected and, owing to the general poverty of small holders at present, legislative control of the disease is not very effective. There would appear to be scope for some propaganda work in this direction, but the absence of any Co-operative movement in Johore renders this very difficult.

Apart from the slight outbreak of Oidium mentioned above, the only leaf disease of any importance has been Bird's Eye Spot (*Helminthosporium Heveae*). This has occurred on young rubber trees on several estates, but in no cases has it been serious enough to require treatment.

Damage by Mites has been recorded, and, to a lesser extent, damage, has been caused by deer, monkeys, and grasshoppers.

Soils.

With one or two exceptions not much interest is being taken in the manuring of old rubber, but replanting in conjunction with manuring is being considered on some of the older estates, especially where rubber is being grown on previously cultivated land.

Catch crops, particularly pineapples, are common in South Johore. There are indications that these can be grown with profit, and without detriment to the rubber, provided the soil is properly conserved, and its fertility maintained by suitable manuring.

On almost all estates ordinary soil conservation work is being neglected owing to lack of funds, but the results of this, as regards erosion, are not so serious, since the policy of clean weeding is now almost generally abandoned.

Towards the end of the year considerable publicity was given to the forestry method of rubber cultivation, and many planters are seriously considering its advantages. It will probably be tried out on a small scale on some estates, but stronger confirmation of its value will be required before it is adopted generally.

General.

The increasing interest of planters and business houses in the work of the Institute is recorded with satisfaction.

(Sgd.) A. Moore,

Field Officer, Johore.

THE RUBBER RESEARCH INSTITUTE OF MALAYA

INCOME AND EXPENDITURE ACCOUNT FOR YEAR ENDED 31st DECEMBER, 1931.

EXPENDITURE.

	$ c.	$ c.	$ c.
To Experiment Station:			
Recurrent Expenditure ...	..		70,041 58
,, Board and Committee Meetings:			
Fees to Members ...	...	3,240 00	
Expenses to Members ...	...	1,045 66	4,285 66
,, Salaries and Allowances:			
1. Senior Staff.			
(*a*) General and Office ...	34,604 17		
(*b*) Research ..	112,077 72		
(*c*) Field ...	23,224 48		
(*d*) Library ...	2,980 00	172,886 37	
2. Junior Staff:			
(*a*) Clerks, etc., ...	15,054 99		
(*b*) Graduate Assistants ...	14,610 00		
(*c*) Laboratory Assistants ...	18,789 40		
(*d*) Field Conductors ...	7,422 97		
(*e*) Laboratory Attendants ...	2,368 50		
(*f*) Library ...	2,858 21	61,104 07	233,990 44
,, Provident Fund:			
Contributions:			
(*a*) Senior Staff ...	...	10,734 11	
(*b*) Junior Staff ...	...	1,501 00	12,235 11
,, Reserves for:			
(*a*) Staff Leave Pay ...	..	33,264 00	
(b) Staff Passages ...	...	3,897 85	37,161 85
Carried forward ...			357,714 64

INCOME.

	$ c.	$ c.	$ c.
By Collections received:			
F.M.S. Government, January-October ...	349,978 81		
S.S. Government, January-December ...	76,591 20		
Johore Government, January-December ...	50,000 00		
Kedah Government, January-November ...	59,414 60		
Kelantan Government, 1st half 1931 ...	5,568 90		541,553 51
,, Collections due and since received:			
F.M.S. Government, November ...			32,087 00
,, Collections due and not yet received:			
F.M.S. Government, December (Estimated)	30,000 00		
Kedah Government, December (Estimated)	7,745 50		
Kelantan Government, 2nd half 1931 (Estimated)	4,135 00		
Trengganu Government, year 1931 .	—		41,880 50
,, Miscellaneous Receipts:			
Bank interest and accrued interest on Investments	2,959 56		
Sales of Rubber, Budwood, etc., ...	1,689 89		
House Rentals	3,142 15		7,791 60
,, Publications: Sale proceeds of:			
Manuals	71 60		
Journals	385 28		
Bulletins	58 60		
Annual Reports	116 35		
Sundry Publications	240 06		871 89
Carried forward ...			$624,184 50

EXPENDITURE—(*cont.*)

	$ c.	$ c.
Brought forward ..		357,714 64
To Rubber Roadways Research: Expenditure to date		19,783 50
,, Staff Recruiting Expenses		4,306 31
,, London Advisory Committee: Secretarial Fees		4,347 36
,, Medical and Hospital Charges	1,875 57	
,, Dental Treatments	570 00	2,445 57
,, Travelling Expenses of Staff:		
(*a*) Within Malaya	14,100 78	
(*b*) Beyond Malaya	284 64	14,385 42
,, Office General Charges:		
Printing and Stationery	1,505 93	
Postages and Telegrams	875 92	
Telephone Subscriptions and Trunk Calls	2,013 08	
Audit Fees	1,000 00	
Legal Fees	680 00	
Sundry Expenses	417 52	6,492 45
,, Rents, Rates and Insurance		5,191 64
,, Laboratory General Charges		1,771 16
,, Upkeep Buildings:		
(*a*) Residential Houses	1,485 44	
(b) Laboratory Buildings	1,550 28	3,035 72
,, Upkeep Laboratory Grounds		531 49
,, Upkeep Furniture		895 67
,, Plant and Machinery:		
Upkeep and repairs	838 20	
Running expenses	6,449 25	7,287 45

INCOME—(*cont.*)

	$ c.
Brought forward ...	624,184 50

To Lorry:				
Upkeep and repairs		250 42		
Running expenses		1,813 83	2,064	25
,, Upkeep Workshop			6	93
,, Laboratory Apparatus and Glassware:				
Replacement and upkeep of			5,178	50
,, Laboratory Chemicals			1,527	21
,, Publications:				
1. Printing:				
(*a*) Journals	2,886 40			
(*b*) Annual Report ...	1,163 40			
(*c*) Bulletins	1,125 40			
(*d*) Sundry Publications ...	3,175 27	8,350 47		
2. Distribution Expenses		1,510 14	9,860	61
,, Library:				
Purchase of Books		1,655 13		
Subscriptions to Periodicals		2,396 13		
Subscriptions to Newspapers		212 24		
Sundry Expenses		1,882 46	6,145	96
,, Film Propaganda			1,752	49
,, Field Experiments			6,021	24
,, Interest on F.M.S. Government Loan			3,037	50
,, Contingencies			4,061	53
,, Exhibitions, Shows, etc., ...			2,866	98
,, Loss on realisation of Investment ...			1,024	89
,, Depreciation for year			68,149	48
			539,885	95
,, Balance Excess of Income over Expenditure for year carried down			84,298	55
			$624,184	50

$624,184 50

INCOME AND EXPENDITURE ACCOUNT FOR YEAR ENDED 31st DECEMBER, 1931.—(*cont.*)

	$ c.		$ c.	$ c.
To Excess of all Income over Expenditure carried to Balance Sheet	89,864 14	By Excess of Income over Expenditure for year, brought down		84,298 55
		,, Collections received in respect of previous periods:		
		S.S. Government		
		Balance 1930 contribution ...	5,359 20	
		Trengganu Government		
		Balance 4th Quarter 1930 ...	206 39	5,565 59
	$89,864 14			$89,864 14

(Sgd.) F. W. SOUTH,
25.1.32
President.

(Sgd.) V. LOUIS CACHEMAILLE,
Secretary,
18th January, 1932.

LIABILITIES.

	$ c.	$ c.	$ c.	$ c.
SUNDRY CREDITORS:				
At Experiment Station ...		...	4,986 25	
Travelling Claims of Staff ...		...	1,407 42	
Sundry Other Creditors ...		...	6,938 71	13,332 38
DEPOSITS:				
For future Publications ...		...		96 70
RESERVES:				
1. Laboratory.				
Staff Leave Pay.				
At 1st January 1931,	71,304 20			
Add Reserve for year,	33,910 00	105,214 20		
Less Paid during year ...		45,031 22	60,182 98	
Staff Passages.				
At 1st January 1931,	28,604 18			
Add Reserve for year,	3,888 00	32,492 18		
Less Paid during year ...		16,351 06	16,141 12	
			76,324 10	
2. Experiment Station ...		...	7,992 00	84,316 10
INCOME AND EXPENDITURE ACCOUNT:				
Balance at 1st January 1931 ...		...	1,095,360 90	
Add Excess of all Income over Expenditure for year ..		...	89,864 14	1,185,225 04
Carried forward ...				$1,282,970 22

ASSETS.

	$ c.	Depreciation for year. $ c.	$ c.	$ c.
LAND AND BUILDINGS:				
1. 132 Ampang Road.				
Land as at 1st January 1931 ...			10,755 00	
Ampang Villa as at 1st January 1931 ...	18,281 94	507 83	17,774 11	
132a Ampang Road.				
Building as at 1st January 1931 ...	41,556 49	1,154 34	40,402 15	68,931 26
2. Land behind Ampang Villa.				
At 1st January 1931			5,001 35	
Add Survey Fees			32 00	5,033 35
3. 5 Circular Road.				
Land as at 1st January 1931 ...			17,147 08	
Old Building as at 1st January 1931 .	14,239 90	395 55	13,844 35	
3 Houses as at 1st January 1931 ...	75,209 07	2,089 14	73,119 93	104,111 36
4. 163 Ampang Road.				
Land as at 1st January 1931 ...			31,440 35	
Old Building as at 1st January 1931 .	13,222 94	367 30	12,855 64	
Carried forward		4,514 16	44,295 99	178,075 97

LIABILITIES—(*cont.*)

	$	c.
Brought forward ...	1,282,970	22

ASSETS—(*cont.*)

	$	c.	Depreciation for year $	c.	$	c.	$	c.
Brought forward			4,514	16	44,295	99	178,075	97
First Five Houses.								
At 1st January 1931 ...	88,559	71						
Add Architects fees re-additional bed-rooms ...	92	50						
	88,652	21	2,471	55	86,180	66	130,476	65
5. 3¼ Mile, Ampang Road.								
Land as at 1st January 1931 ...					45,422	50		
Second Five Houses.								
As at 1st January 1931 ...	80,294	15						
Add additions during year ...	134	16						
	80,428	31	2,139	95	78,288	36	123,710	86
LABORATORY BUILDINGS:								
As at 1st January 1931,	57,335	89	11,467	18			45,868	71
PLANT AND MACHINERY:								
Electric Plant.								
As at 1st January 1931,	5,465	72	1,366	43	4,099	29		
General Machinery.								
As at 1st January 1931 ...	20,263	88	3,039	58	17,224	30	21,323	59

LIABILITIES—(*cont.*)

Brought forward ...		1,282,970 22

ASSETS—(*cont.*)

		Depreciation for year		
	$ c.	$ c.	$ c.	$ c.
Brought forward		28,786 96		546,175 82
LABORATORY EQUIPMENT AND APPARATUS :				
As at 1st January 1931 ...	58,850 69			
Add Additions during year ...	941 13			
	59,791 82	11,906 96		47,884 86
MOTOR LORRY :				
As at 1st January 1931 ...	668 33	167 08		501 25
WORKSHOP EQUIPMENT :				
As at 1st January 1931 ...	1,145 45	171 82		973 63
EXPERIMENT STATION :				
Development Expenditure as at 1st January 1931 ...	471,840 89			
Add Expenditure during year ...	87,184 12			
	559,025 01			
Less Recurrent Expenditure during year transferred to Income and Expenditure Account ...	70,041 58			
	488,983 43	27,116 66		461,866 77
Total depreciation		68,149 48		

LIBRARY BOOKS AND PERIODICALS:				
As at 1st January 1931 ...			1 00	
Add Purchased during year ...			4,051 26	
			4,052 26	
Less written off during year ...			4,051 26	1 00
STOCKS IN HAND:				
Petrol and Oil.				
Laboratory		173 19		
Experiment Station ...		52 78	225 97	
Petrol Empties and Gas cylinder.				
Laboratory		95 00		
Experiment Station ...		152 25	247 25	
Stationery			585 54	
Sundry Materials.				
Laboratory		376 14		
Experiment Station ...		1,106 97	1,483 11	2,541 87
PAYMENTS IN ADVANCE:				
Against Survey Fees.				
Travelling Claims etc. ...		1,693 23		
Against Chemicals etc.,				
in transit		189 89		1,883 12
SUNDRY DEPOSITS:				
Against Water Supplies.				
Telephones, etc., ...				290 00
Carried forward ...				1,062,118 32

Carried forward ...	1,282,970 22

LIABILITIES—(*cont.*)

Brought forward ...		1,282,970 22

ASSETS—(*cont.*)

		$ c.	$ c.	$ c.
Brought forward ...				1,062,118 32
ADVANCES TO STAFF FOR MOTOR CARS, ETC:				
Senior Staff.				
Laboratory ...	...	1,460 00		
Experiment Station	...	600 00	2,060 00	
Junior Staff ...	...		686 30	2,746 30
SUNDRY DEBTORS:				
F.M.S. Government	...	62,087 00		
Kedah Government	...	7,745 50		
Kelantan Government	...	4,135 00		
Trengganu Government	...	—	73,967 50	
At Experiment Station	...		336 78	
Sale of Publications	...	82 61		
Sundry Other Debtors	...	1,718 89	1,801 50	76,105 78
INVESTMENTS:				
F.M.S. Government 4½% Loan				
Nominal value, $65,000	...		64,744 62	
British War Loan 5%				
Nominal value £5,750	...		46,857 16	111,601 78
CASH AT BANK AND IN HAND:				
Rubber Growers' Association, London	...		3,432 48	
Chartered Bank, London	...		1,686 05	
Chartered Bank, Kuala Lumpur.				
Board's Account	...	4,331 23		
Working Account	...	10,598 06		
Experiment Station	...	1,675 02	16,604 31	

(Sgd.) F. W. SOUTH,					
25.1.32					
President.					
					$1,282,970 22

Mercantile Bank Ltd., Kuala Lumpur					
Board's Account	...		8,556 92		
Petty Cash					
Laboratory ...	...	32 18			
Experiment Station	...	86 10	118 28		30,398 04
					$1,282,970 22

I hereby certify that to the best of my knowledge and belief all liabilities to the 31st December, 1931 have been brought into account at that date.

(Sgd.) V. LOUIS CACHEMAILLE,

18th January, 1932. Secretary,

We have audited the above Balance Sheet and Income and Expenditure Account with the books and vouchers of the Rubber Research Institute and certify same to be correct according to the best of our information and explanations given us and as shewn by the books of the Institute.

Kuala Lumpur,

22nd January, 1932.

(Sgd.) GIBSON, ANDERSON, BUTLER & CO.,

Chartered Accountants,

PUBLICATIONS.

Publications of the Rubber Research Institute are issued in the following forms :—

(1) *Planting Manuals* appearing at irregular intervals at a price to be fixed for each number.

(2) *Bulletins* appearing occasionally at a price to be fixed for each number.

(3) *Journal R.R.I.* appearing at irregular intervals each year.

All publications will be issued free to those with active rubber planting interests in Malaya.

The following publications have been issued and copies can be obtained on application at the prices given against each

Bank commission should be added to outstation cheques.

(a)	Planting Manuals.	
	No. 1, "Preparation of Plantation Rubber" by B. J. Eaton ..	$2.00
	No. 2, "Budding of Hevea in Modern Plantation Practice" by F. Summers ...	$2.00
	No. 3, "Plantation Sheet Rubber Manufacture" by R. O. Bishop ...	$2.00
(b)	Journal of the R.R.I., Vol. 1, Nos. 1 and 2	$1.00
	Separate copies of other numbers ... ... (each)	0.50
(c)	Annual Reports from 1928 ... ... „	$1.00
(d)	Bulletin No 1. Natural Coagulation of Hevea Latex by A. S. Corbet	$1.00
	Bulletin No. 2. A Study of the effect of Damp Storage on Raw Rubber by B. J. Eaton and R. G. Fullerton	$1.00
	Bulletin No. 3. The Root Disease Problem on Old Rubber Areas in Malaya by A. Sharples and A. R. Sanderson ...	$1.00
	Bulletin No. 4. Summary of Meteorological Records, Soils Division, by W. B. Haines	$1.00
(e)	Information Cards, dealing with various phases of Rubber Estate Factory Practice and Defects in Raw Rubber.	Free
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